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WOMEN,

PLUMBERS, AND DOCTORS;

WITHDRAWN FROM THE LIBRARY OF

HOUSEHOLD SANITATION.

BY
MRS. H. M. PLUNKETT.

Showing that, if women and plumbers do their whole sanitary duty, there will be comparatively little occasion for the services of the doctors.

ILLUSTRATED.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.
1885.

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TO

DR. HENRY I. BOWDITCH,

WHOSE

EARLY, PERSISTENT, AND ENTHUSIASTIC LABORS

MAKE HIM

THE APOSTLE OF SANITATION IN AMERICA,

THIS LITTLE MANUAL IS DEDICATED BY

H. M. P.

282568

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TO CRITICS.

THOSE who, observing the generous quotations herein from high sanitary authorities, may say, "The book lacks originality," are reminded that sanitary science is a science of collated facts; that the aim has been to be instructive rather than original; to concentrate the existing light of to-day upon one small field—the home; and if the veteran sanitarian should encounter familiar "instances" and illustrations, he is reminded that the present endeavor is to arouse the interest and practical efforts of a new class—the women.

PITTSFIELD, MASS., *October, 1884.*

WITHDRAWN FROM THE LIBRARY.

WOMEN, PLUMBERS, AND DOCTORS.

CHAPTER I.

HYGIENIC HOUSES.

"The prevention of disease is a higher and more useful branch of medicine than therapeutics."—AUSTIN FLINT, M. D.

"Pure air, pure water, and pure soil."—*All sanitarians.*

Why women should understand the details as well as the theory of sanitation.

"And the gentleman said the cellar was all right—I mean as to the drain-pipes and the furnace and all that; and so I suppose it is." This was the closing sentence of an animated account, which a devoted wife and mother had been giving of her experiences in house-hunting. Her husband, whose circumstances forced him to remain in the city, was just recovering from what had seemed an onset of consumption, and she had been telling how the house they had chosen "was so adapted to Mr. X——'s recovery." It was a corner-house, every room lighted; they were all high and airy; there was an open fireplace in every one; a transom over the door of every sleeping-room; not one "set" bowl in a bedroom; she had studied and tried to comprehend the complicated "piping" of the house; had convinced herself that every trap was ventilated, and she congratulated herself that every desirable point was secured. She thought she had done her whole duty; but her vigilance gave out at the ground-floor—beyond that she had relegated the investigation to her husband and brother. To be sure, she

had seen that there were stationary tubs in the laundry, but into the dark recess that called itself the cellar she did not penetrate. Why? Simply because she had grown up in the belief that the care of that semi-telluric region belonged naturally to the gentlemen of a household. To her, its dark, damp spaces were weird, forbidding, and uncanny; she would as soon have thought of mastering the mechanism of the engine in her husband's factory as of studying the proper construction of a foundation-wall, a cellar-bottom, or a cold-air box. She was a tender wife and loving mother, and meant to do her whole duty in defending the health of her household; she is the representative of thousands, and to such as she these pages are addressed. The beautiful part which Mrs. Roebling, the wife of the Brooklyn Bridge engineer, took in aiding its completion, has demonstrated that, with a sufficient motive, women can rise above the beaten paths of cookery and needlework to some purpose.

Women are more interested in preventive medicine and household hygiene than men.

To the woman, whose destiny it is to remain a large share of the time at home, whose divinely appointed mission it is "to guide the house," a new sphere of usefulness and efficiency opens with the knowledge that in sanitary matters an ounce of prevention is worth a ton of cure. There is nothing in hygiene that she can not comprehend, and too often does she realize this and begin to study it, when, too late, she stands beside the still form of some precious one, slain by some one of those preventible diseases that, in the coming sanitary millennium, will be reckoned akin to murders.

More than four years ago Dr. B. W. Richardson, President of the British Medical Association, said: "I want strongly to enforce that it is the women on whom full sanitary light requires to fall. Health in the home is health everywhere; elsewhere it has no abiding-place. I have been brought indeed by experience to the conclusion that the whole future progress of the sanitary movement rests for permanent and executive support on the women of the country. When, as a

physician, I enter a house where there is a contagious disease, I am, of course, primarily impressed by the type of the disease, and the age, strength, and condition of the sick person. From the observations made on these points I form a judgment of the possible course and termination of the disease, and, at one time, I should have thought such observations sufficient. Now I know them to be but partially sufficient. A glance at the appointments and arrangements and management of the house is now necessary to make perfect the judgment. By this glance is detected what aid the physician may expect in keeping the sick in a condition most favorable for escape from death; and by this is also detected what are the chances that the affection will be confined to one sufferer, or distributed to many. As a rule, to which there are the rarest exceptions, the character of the judgment hereupon is dependent on the character of the presiding genius of the home, or the woman who rules over that small domain. The men of the house come and go; know little of the ins and outs of anything domestic; are guided by what they are told, and are practically of no assistance whatever. The women are conversant with every nook of the dwelling, from basement to roof, and on their knowledge, wisdom, and skill the physician rests his hopes. How important, then, how vital, that they should learn, as a part of their earliest duties, the choicest sanitary code."

What is Sanitation?—It is the practical application of sanitary science and the laws of hygiene to the maintenance of health.

The first step is to learn upon what physiological conditions the building up of a healthy body depends. The gardener understands perfectly that, if he wishes to bring a plant to its highest perfection, he must plant it in the right spot, where it will receive a due amount of moisture and sunshine; that it must be nourished with just the appropriate elements, and protected from noxious emanations of soil and air: otherwise it will either die outright, or attain only a stunted, puny, worthless growth. Ask him why he doesn't plant wheat in swampy

ground, and he will tell you that "it is contrary to its nature to thrive in a wet soil." Then ask him what effect damp soil has on human beings whose houses are planted in it: he will either give you a look of amazed surprise, as much as to say, "I never thought of it," or he will frankly own, "I don't know."

The human body is an organism that requires for its growth, development, and maintenance in health, a combination of forces far more complex and delicate than ever went to the perfecting of the finest field of wheat; and, in order to understand what the ideal sanitary conditions are, we must begin at the beginning, and inquire what the ideally healthy body needs.

How do we live?—Nine persons out of ten would answer, "by food and drink," entirely ignoring the influence of the great invisible ocean in which we live and move and have our being. It is justly called vital air, for if you deprive a man of it completely for five minutes he dies. Fill a flower-pot with suitable earth, and plant a slip of ivy in it, and supply it with water; it will form a growth of vines and leaves that will outweigh many times the earth and water. One grown in a quart-pot formed the decoration of a large room, and, when taken down, filled a large wash-tub. Whence came this growth? It was elaborated from the carbonic acid of the atmosphere, sent out from the millions of fires and furnaces and chimneys on the earth, and countless myriads of human lungs. Although carbonic acid constitutes but one two-thousandth part of the whole air, Professor Dalton computes that there are rather more than thirty tons of it above each acre of ground. If this could be concentrated into a tangible form, like so much coal or sand, we should begin to form some notion of the amount of material dissolved in the air.

The same empyrean ocean holds four hundred times as much oxygen dissolved, and from this enormous reservoir we draw a fresh portion into our lungs once in three seconds. Here, through the agency of an infinity of microscopical air-tubes, it is brought in contact with every drop of blood, which it changes from the deep purple, carbonic-acid laden fluid to

the bright scarlet, oxygen-charged river, that is to bear its tissue-renewing riches to every microscopical iota of all the millions that make up our various structures, each and all of which are thus undergoing a perpetual death and a never-intermitted resurrection. It is perfectly clear that the elimination of effete materials and the supply of fresh ones must exactly balance, or the functions of life will become disordered. If the carbonic acid is not taken out, the blood becomes poisoned. If the building-material—the oxygen—is not supplied in sufficient quantity, the body is not perfected, and the structure, like a house made from half-burned bricks, will be ready to fall on slight provocation.

Poison in the Air.—Says Dr. R. Angus Smith, of Edinburgh: "Some people will probably inquire why we should give so much attention to such minute quantities"—he was writing on "Chemical Climatology"—"as between 20·980 and 20·999 of oxygen, thinking these small differences can no way affect us. A little more or less oxygen might not affect us, but, supposing its place occupied by hurtful matter, we must not look on the amount as too small. Subtracting 0·980 from 0·999, we have a difference of ·019 in a million. In a gallon of water there are 70,000 grains; let us put into it an impurity at the rate of ·019 in a million; it amounts to 13·3 grains in a gallon. This amount would be considered enormous if it consisted of putrefying matter, or any organic matter usually found in waters; but we drink only a comparatively small quantity of water, and the whole thirteen grains would not be swallowed in a day, whereas we take into our lungs from one thousand to two thousand gallons of air daily. The detection of impurities in air is, therefore, of the utmost importance; and it is only by the finest methods that they can be ascertained in small quantities of air, even when present in such quantity as to prove deleterious to health. . . . If by inhalation we took up at the rate of thirteen grains of unwholesome matter per day—half a grain per hour—we need not be surprised if it hurt us. Such an amount is an enormous dose of some poisons, and yet this is not above one two-thousandth

part of a grain at every inhalation. It is marvelous what small amounts may affect us, even when, by repeated action, they do not accumulate as certain poisons do."

Food and Drink.—Every step we take, every stitch we sew, every blow we strike, every note we sing, every word we speak, every thought we think—in short, every vital act we perform, either bodily or mental, requires a certain amount of vital force, i. e., it causes the transformation of more or fewer of those particles which the physiologists call anatomical elements into exhausted, used-up, "dead" material. To make good this perpetual spending there must be an unremitting assimilation of new material—we must eat and drink and be nourished, or we shall soon hear "bankrupt" from the inexorable keeper of the "house of life." By an unerring elective chemistry, the exact material to build up each tissue is selected from the blood, in which the food and drink are mingled, after having been liquefied and comminuted in the digestive apparatus; while that which has done its work, or is not suited to the purpose, is rejected and eliminated by the appointed channels. If this effete or unadapted material, which has now become hostile, alien, and poisonous, remains, it will destroy the body: uræmic poisoning requiring three days, and failure to excrete solid matters less than a month. The skin aids in ridding the system of the superfluous salts, by the perspiration; but the fact to be emphasized in all these operations is, that, by whatever channels these rejected particles leave the system, they are henceforward to the human body poisons, and must be rigidly excluded from it—a thing much more easily said than done; therefore the attention of the sanitarian must be concentrated on securing an adequate supply of *good food, pure air, and pure water.*

Food.—Since the day when Abraham left the three angels waiting outside, and hastened into the tent, and said, "Make ready quickly three measures of fine meal, knead it, and make cakes upon the hearth," the preparation of the food of mankind has been largely in the hands of the women of all the tribes and nations of the earth. The knowledge that has been

brought to bear has been empirical and traditional. Till within two hundred years, such a thing as a *science of cooking* was unknown. Now that it has been made a study by able minds, the French lead all the world in the art of preparing digestible, nutritious food. It was a Frenchman who said, "He that discovers a new dish confers a greater benefit on mankind than he who conquers a province." The ancient Romans showed a fine insight, when they declared that man the best fitted for his share in the world's work who had a sound mind in a sound body—"*Mens sana in corpore sano.*"

Even in this day of enlightened progress there are a multitude of people who underestimate the value of a healthy body; they are dominated by the monkish notion of crucifying the flesh; they feel that it is regarding life from a very low plane to bestow so much thought on perfected physical conditions—that it is of the earth—earthy. They forget that the loftiest soul is very dependent on the body that encases it. No man is a hero with a raging toothache. Carlyle is a vivid example of the way in which a "cranky" stomach can warp and pervert the noblest powers. But the ascetic spirit which ignores and despises the body is fast dying out, and men realize that intellectual ability, as well as the vigorous will, that is the highest factor in spiritual power, are very dependent on bodily conditions. The glowing saint, John Wesley, gave the aphorism, "Cleanliness is next to Godliness," to the English language in a sermon. Charles Kingsley struck some of his mightiest blows for sanitary reform, and urged the clergymen of England to agitate the subject as part of their bounden duty to their flocks. Our Lord himself gave us his estimate of the body, in that nearly all his miracles were wrought either to restore or feed it. By what right, then, do we despise the temple of the Holy Ghost? What God hath joined together let not man, either by ignorance or apathy, put asunder.

More and more, year by year, physicians are learning that malnutrition lies at the root of the majority of diseases, and they are earnestly directing their attention to the discovery of assimilable foods; hence we hear of the "whey-cure," the

"grape-cure," the "milk-cure," the "muscle-pulp cure," and many others.

It is a part of the enlightened progress of the time that educated women are rousing themselves to study the principles that underlie the preparation of digestible and therefore assimilable and nutritious food; they begin to perceive the dignity of the art of cooking, and are proud to be able to give an intelligent reason why one piece of meat should be broiled over a brisk fire for a few minutes, while another must undergo slow and long maceration in water, cold at first, and afterward gradually heated till all the albumen has been softened and extracted. The cooking-schools are doing a noble work, and the discussions of the theme in the daily press have aroused such a universal interest that, even in a work on sanitation, it may be dismissed with a paragraph. With the legions of good cook-books, and the ceaseless agitation on the affairs of one of the largest provinces of woman's kingdom, it is to be hoped that a speedy exit awaits the frying-pan, soggy potatoes, and sour bread. The cooking reform will take care of itself; so we propose to concentrate attention on the less obvious but equally important topics of pure air and pure water; and, in order to secure the first, the woman who means to preside over a perfectly sanitary home must begin at the beginning and exercise her first vigilance in the choice of the spot on which the house will stand.

CHAPTER II.

UNDER THE HOUSE.

A Salubrious House-Site.—We will first consider the location of detached houses in the country. Twenty-five years ago the influence of *soil-moisture* and *ground-air* on health was little thought of. It was the custom in villages to place houses so that they should have the proper alignment with neighboring houses; a gentle knoll, that commanded a pleasant prospect, often determined the site of the isolated farm-house, or more often a nook at the edge of a wood, or the shelter of a spreading tree, was the deciding element. Too often the fascinating tree was a huge indigenous willow, which ought in itself to have been a complete condemnation of the spot as too wet for a house. Where willows grow spontaneously, the soil is so damp that the exhalations constitute a perpetual cold vapor-bath—how cold, let those testify who have driven over some springy, ozier-bordered stretch of road at night-fall. Fifty years ago the leading idea in choosing the house-site was nearness to water, and "handiness" generally—handy meaning convenient. Sometimes the decision was modified by the supposed protection from cold, furnished by a hill, against the prevailing winds of the section; placing the house "under cover of a hill" for warmth was poor policy. Better let the house have the superior drainage of the hill, and defend it against the wintry blasts by a belt of our native evergreens planted to windward. There is no such efficient way of counteracting a cutting "nor'easter" as a curtain formed of these, so that the wind is sifted through the million leaflets of hemlock and pine, and its force divided into harmless infinitesimal portions.

Instead of doing this, too often we see an impenetrable for-

est of trees planted in the front-door yard, so near the house as to completely shut out the life-giving sunlight. People have yet to learn that sunshine is just as necessary to the perfect development of the human body as it is to the trees and flowers. But here woman is the one to suffer by the vital omission. The vocations of the great majority of men call them out into the sunlight, but their wives and daughters remain in-doors mostly. Did you ever see a long, attenuated, *white* potato-vine, that had grown in the cellar from some neglected tuber left behind after the spring cleaning? To be sure, it did its best, and reached forth toward any ray of light that struggled in through any little open chink; but compare it with the stout, deep-green, luxuriant cousin grown in the open field. These present a violent contrast, but it is in reality no greater than the effects of sunlight or *no sunlight* on persons as well as things, though it is carried a little farther in the case of the helpless sprout than in that of the pale, weakly girl, who grows up on the floor above it.

There are houses overhung by picturesque, but light-and-heat-excluding trees, so that bright-green mosses are thriving on the shingles; just such mosses as spring up in the deep, sunless recesses of the forest. We will venture to say that every country reader of this book can find at least one such house, and sometimes it will not be so very old. A roof where mosses naturally grow is just as much too damp to live under as a soil where willows naturally grow is too damp to live over.

By thus planting too many trees near the house, the very beauty sought is lost; the trees choke and deform each other, and entirely prevent the growth of grass, which, of all rural surroundings, is most attractive and satisfying. C. D. Warner says, "The Anglo-Saxon race emigrate in the line of grass;" and, as it utterly refuses to grow in sunless spots, another good fundamental rule in house-planting would be: have a wide belt of healthy grass entirely around the house.

In examining the replies sent to Dr. Bowditch on the causes of consumption, a great objection to locating a house even on the sunny side of a dense natural piece of "woods" shows itself.

Some malign influence seems to exhale from the dead leaves which form the carpet of the forest; and the late studies of Tyndall and Pettenkofer help to explain what it is.

Shall we, then, have no trees about our houses? Why do we admire them so much if they are so deleterious? The reply is, that a few trees at a proper distance, and so planted as not to intercept the sunlight, are a positive sanitary benefit; they are the natural absorbers of surplus carbonic acid; and if one can find a "ready-made" one, so much the better; but do not place the house too near the tree. If there are none, plant a few at such distances that each tree can develop in the perfected form designed by the Great Artificer. Such trees, placed at a proper distance, lend an air of dignity and repose to a house, and make them seem parts of a complete and harmonious whole, in which the house shows for all that it is, and the trees for all that they are, instead of obliterating each other's lineaments, and "killing" a dwelling to which they should have formed graceful adjuncts.

Without claiming positive and direct sanitary value for beautiful surroundings, we still believe it is a great mistake to ignore those irrepressible yearnings for the finer life, that show themselves in the love for attractive surroundings.

Many a man who has failed to make a home, or, strictly speaking, a homestead, that his children can love, has been doomed to see them leave it, and seek in other places, and amid new surroundings, those satisfactions that have been denied them in what should have been the dearest spot on earth. The charms of a beautiful home would go far to kindle and keep alive that enthusiasm which sustains the soul, enabling it to triumphantly contend against discouragements and obstacles. Whether the sanitarian of the future will push his investigations so far as to be able honestly to write the epitaph, "Died of neglected æsthetics," or not, the statistician of the present is justified in saying, that the sum of possible human happiness, perhaps health as well, is being constantly subtracted from, by the failure to adorn and make pleasant the paths of daily life.

Soil Moisture.—Even in the time that may justly be called the prehistoric time of sanitary knowledge, there was a degree of soil-moisture that forbade the building of a habitation; but anything like an experimental scientific knowledge of the different effects to be expected from dry ground, or that saturated with moisture, was not dreamed of. It is now nearly thirty years since Dr. Henry I. Bowditch inaugurated a systematic inquiry, through a circular-letter addressed to the physicians of Massachusetts, as to *consumption:* its extent, concomitants, and, as far as discoverable, its causes. A comparison of the answers produced a genuine surprise. The largest factor did not prove, in accordance with *a priori* theories, to be heredity, insufficient food, overcrowding, sudden exposure to extreme cold, nor contagion; but *living on a wet soil!* This surprising hint had a speedy confirmation in statistics gathered in England by Mr. Simon, medical officer to the Privy Council, as to the effect of drainage works that had been undertaken on an extensive scale in many large towns. It was uniformly shown that the drying of the soil diminished the number of cases of consumption. Thus these two investigators, working on different lines, and unknown to each other, demonstrated that, though by no means the sole cause of consumption, here was one of its most prolific ones. These investigations and deductions attracted the attention and quickened the observation of medical men everywhere, so that, when fifteen years later, Dr. Bowditch, as chairman of the Massachusetts Board of Health, asked the question, "Is consumption ever caused or promoted by a wet location?" they were prepared to embody the fruits of years of intelligent observation in their replies. Of 191 addressed, 168 answered, without hesitation or qualification, "yes," two were "doubtful," and twenty-one said "no." Some of these held strong prepossessions as to "infection," "the use of pork as food," "insufficient nutrition," "heredity," "overwork," "working in crowded rooms," "mental shock or depression," "too much shade," etc., etc. Dr. Elisha Harris,* the present head of the New York State Board of

* Deceased, January, 1884.

Health, wrote to Dr. Bowditch: "Inquiries that I had begun upon general sanitary questions in every town in the State of New York in 1859, as a committee of the State Medical Society, prepared me to believe your opinions (viz., that soil-moisture is a prominent cause of consumption in New England, and probably elsewhere) were well founded when you first mentioned them to me in 1862." Here stood revealed one of the causes of the most universally destructive disease in the world —it caused ninety-five thousand deaths in the United States in 1880. Here, stripped of all "mystery," is the ascertained fact that it is quite within the scope of human ability to lessen its ravages.

We quote one of the replies sent to Dr. Bowditch in full, because it is a graphic picture of house-conditions that may be found in many places, and because it throws light on the influence of dry, or water-logged soil, which we shall consider presently. If the author of the reply has followed the recent investigations of the Germans on *ground-air*, and its influence on health, he will find the puzzle presented in the two houses partly solved. He says: "The causes of consumption are sometimes past finding out, as the following circumstances will show: Two brothers, living in this town, when young men built themselves houses not more than fifty or sixty rods apart; one built a wooden house on a slightly elevated sandy locality —the house is not shaded, but takes the sunshine freely throughout the day. In this he reared a family of twelve children, eleven of whom are now living, the youngest being about thirty years of age; a part of the family still occupy the house, and no case of consumption has ever occurred in the family. The other brother built a brick house on a spot neither elevated nor low; the site is not wet, but *is not as dry*, and is a little less elevated than the point selected for the wooden house built by the first brother. Here he reared eleven children, and has probably occupied the house forty years. The house is considerably shaded on the south front. Within the last twenty years there have occurred, in this family, nine cases of consumption. Both of these houses front to the south, and

both are equally exposed to the northwest winds. Consumption is not hereditary in either family through father or mother. In regard to the mortality attaching to the brick house above mentioned, the shading of the south side can not be considered a cause, as the disease first showed itself before the trees were large enough to shade the premises. I can call to mind several similar instances." A brick house on a moist soil, built as they formerly were with no thought of a "damp-course," was, by reason of its capillarity, a modified sponge, which drew up and retained the soil-water, and by its evaporation created a chilled air. The writer continues: "I know another family, in which consumption is not hereditary, who occupy a house in which sunshine can hardly enter, in consequence of shade-trees and the peculiar build of the house, which has lost six children by consumption. They all arrived at adult age, however, before disclosing symptoms of the disease.

"My own conviction has been for years that consumption loves a moist locality and a dark dwelling. I have noticed that houses built upon a *dry subsoil*, and so constructed that they admit the sun freely, are generally free from consumption. A dry locality, with plenty of sunshine, warm clothing, and good living, will never breed consumption; while these blessings surround a person he may, even if he inherits a predisposition to consumption, keep the disease at bay, and live to a good old age."

Here is one more picture of a house "all wrong," with such a result as might be expected. It is a letter from a physician whose theory of consumption was heredity; but the reader can judge for himself: "In 1831 Rev. Dr. B—— came to this place and was settled over the Congregational Church. He occupied a house situated upon an *apparently* dry and healthy, and slightly elevated, piece of ground, but the sills were very near the ground, and from the bank (once the margin of the Connecticut River), some three or four rods distant from the house, issued numerous springs. Here is the mortuary record:

Eldest daughter, L., died in		1837,	aged	22,	of consumption.
Mother,	"	1838,	"	43,	"
Father,	" March,	1839,	"	53,	"
Eldest son,	" May,	1839,	"	15,	of diabetes.
Second daughter,	" July,	1839,	"	22,	of consumption.
Youngest son,	" September,	1839,	"	2½,	"
Third daughter,	" April,	1840,	"	23,	"
Fourth daughter,	" October,	1840,	"	20,	"
Youngest daughter,	"	1855,	"	20,	"

Another son, who had lived on this springy site till seven years old, was kindly adopted in another part of the State. He died at seventeen, of consumption, and the youngest daughter removed to another town and was cared for there, but did not escape the family doom. The only one who lived to middle life was reared, after he was ten, in an exceptionally healthy Connecticut town, and, after graduating at college and studying law, settled in Indiana, and at about the age of forty-five died in the street, of instantaneous hæmorrhage from the lungs.

The sandy soil on which the wooden house stood in the first letter quoted, was not "retentive," but the other was lower and wetter, and of course the state of the air above the ground immediately surrounding the two houses was different, and the cold produced by constant evaporation, even where it does not become a fog, and consequently a visible damp bath, is a direct element in lowering the vitality of those who live in it.

Says Colonel Waring: "The exact cause of fever-and-ague and other malarial diseases is unknown, but it is demonstrated that, whatever the cause is, it is originated under a combination of circumstances, one of which is undue moisture in the soil." The Board of Health of England sums up a vast mass of convincing testimony, at the close of a voluminous report, in these words: "The evaporation of the surplus moisture lowers the temperature, produces chills, and creates, or aggravates, the sudden and injurious changes or fluctuations by which health is injured." It is also one of the most universally recognized facts, by medical men, that diseases that are not distinctly miasmatic become much more severe in a miasmatic district.

It has been proved, by careful experiments in England, that the average evaporation from wet soils is equal to a depth of *two inches per month*—in America it is greater—and an idea of the heat lost to the soil may be formed by remembering that to evaporate this depth on an acre (equal to two hundred tons) by artificial heat would require twenty tons of coal. As all this heat is abstracted from the air and the soil, there is no wonder that "a chill strikes us" as we enter on premises where this process is going briskly on.

If imperative circumstances finally oblige a man to choose a site that is damper than he likes, his wife can insist on the application of the cheap and efficient remedy of thorough subsoil drainage. There are books that give simple and plain instructions as to the minutest details, so that a man can be his own "engineer," and superintend the work of common laborers, as it does not need skilled labor. Probably a man can get a richer return for capital invested thus than in any other way, for, day in and day out, through all the year, even while he is sleeping, it will be working for him to make his home healthy.

It would require too much time, and take us into too technical a field, to describe the tests and indications of a soil too damp for human habitation, and there is less need for it, as full directions are to be found in works on drainage.

Dr. George Derby, the able first secretary of the Massachusetts State Board of Health, said in 1871 (a very remote period in the history of public hygiene in America): "We have no disposition to enter at length upon so obscure a subject as the influence which may be exerted on health by dwelling on special soils, yet we can not forbear to express our conviction that, in this direction, will ultimately be found an explanation of many things in the history of disease which are now mysterious. The property which earth possesses to render harmless the most revolting substances; the salutary virtues which fresh clods of earth are known to possess in removing animal poisons, as known to the Indians; the influence which dwelling on *wet* soil has been recently shown to have upon consumption; the influence (recognized in all time) which certain

soils have upon intermittent and remittent fevers—all these observations point to *the earth*, and the changes, as yet unexplained, which are there constantly taking place as the source of influences bearing directly upon our health and life." This was one of those prescient intuitions that come to gifted minds; it was not given to Dr. Derby to live to witness the confirmation of his brilliant surmise, through the labors of such men as Pettenkofer, Klebs, Tommassi-Crudeli, Tyndall, Pasteur, and Darwin, and being pursued at this hour by an army of the true heroes of science, who, with the microscope and the condensed electric beam, are wringing the innermost secrets from the very heart of nature.

Porosity of the Soil and its consequences.—Dr. Derby further says: "Some of the possible influences of soil on health become more intelligible when we consider how much air it contains, and how readily this may become the means of transmitting anything the soil may hold to those who dwell above it. A vessel of any sort filled with dry earth, compressed as much as possible, will still absorb one quarter to one third of its bulk of water without overflow. All this water represents space which has been previously occupied by air. If we look upon the soil as a kind of cover to what lies beneath it, we must remember that the cover is not tight, that it is always partly open, and that whatever recondite properties the soil may hold, whether for good or for evil, will be sure to come to the surface through the agency of air, which must change its position with the slightest change of temperature, such as must be occasioned by the alternations of day and night. Gases produced by decomposition must of necessity rise to the surface. Moreover, our houses are, in effect, bell-shaped inclosures, in which are retained, with more or less completeness, whatever the soil beneath us may have to render up."

If any one doubts that what is beneath the house can and will penetrate upward through floors, ceilings, and all parts of it, let him close the cellar-doors and windows and boil a kettle of onions, or unstopper a flask of ether in it, and then go to the

attic of even a six-storied building—his nose will soon convince him that there is an upward draught of no mean abilities.

It seems impossible that towering buildings should stand on a substance that is as porous to air as a sponge is to water, but it may be roughly stated that the ground on which we walk is one third air, and this air is never at rest, being affected not only by every slight change in the temperature, and many other circumstances at the surface, but also by every rise and fall in the level of the ground-water, which underlies every place, and which experiences its widest fluctuations in seasons of drought or of abnormal rain-fall. The study of the microscopical growths that are now found to constitute the special virus of so many diseases has given a new significance to the study of the composition of the ground-air, as the inter-spaces between the particles of soil afford, relatively speaking, galleries and grottoes where whole forests of the microscopical fungi and molds can germinate, grow into tiny trees, ripen their seeds, and die. The question at once suggests itself, What is there in the soil that can make it merit the adjective healthful at one time, and disease-bearing at another? Here is Pettenkofer's answer: "The property which renders any place injurious to health is probably derived from those minute organisms, or their products, of which many million individuals can be put within the area of the head of a pin, and which inhabit the porous soil, from the surface down to a great depth—organisms which are capable of being injurious or harmless, or even useful to us, as we are already acquainted with injurious and useful plants and animals. They have heretofore been invisible to us, having just been brought to knowledge in the course of recent investigations in vegetable and animal physiology and pathology, by means of the microscope and experimental cultivation."

No wonder the ancients believed in potent malign spirits of the earth, who rose out of it and cast a baleful gloom over the spot blighted by their presence. The specific difference between the atmosphere and ground-air is found to consist in the greater proportion of carbonic acid in the ground-air,

which increases, as a rule, with the distance from the surface, and this carbonic acid is derived chiefly from organic matters and organic life in the ground—with this it increases or diminishes. In the light of the foregoing, it is easy to see that houses placed on a disease-bearing soil, without protection, are placed on the ground barefooted. Any one can think of many examples of this partial nakedness; the pile-supported houses of so-called barbarians and the clay-floored house of the poor foreign peasant were better off in this respect. Experiments with the differential manometer have demonstrated that through most of the year the air flows from the ground into the house, the air which is sucked into the house brings dust with it, and, when they exist beneath it, disease-breeding germs also.

In this day of scientific marvels, when the biologist and microscopist are drawing the world forward on an express-train, the architect has had to rouse himself so as not to be left behind—to bestir himself for means of counteracting sanitary evils; and the best antidote that he has found to counteract the entrance to houses of destructive germs from below is a plate, on the cellar-bottom, of Trinidad asphalt, laid on a well leveled and compacted bed of concrete. The houses best worth living in, in Europe and America, are to-day being thus furnished with an impervious overshoe—for this material is as impervious as glass.

When we think of the ground beneath our feet as teeming with animal and vegetable life, and when we consider the influence of moisture and heat on these, it becomes easy to understand why under-draining, that renders a moist piece of earth dry, transforms it into a healthful spot.

The fatal effects of being obliged to pass a night on the Pontine marshes are universally known, and Tommassi-Crudelli has a remark of the highest interest in his recent work on the malaria of Rome and the former drainage of the Roman hills, to the effect that the ancient Romans suffered much less from fevers, than the Romans of after times and to-day. The archæologist De Tucci, having called attention to some underground canals of a peculiar kind, called *cuniculi*,

in the Roman hills, Tommassi examined them and found that they were designed exclusively to drain the hills, and that they were now choked up and inoperative. Formerly, he thinks, they were so familiar that the ancient Roman writers did not think it worth while to speak of them; they passed into forgetfulness during the irruptions of the barbarians, and the middle ages, and have now had to be discovered anew.

The Site of the City House.—Here the selection becomes at once complicated with questions of cost; distance from business; disagreeable neighbors, animate or inanimate. Fashion often places her supreme ban on a most salubrious section, and her equally dominant approval on a spot filled with the seeds of fever and ague, typhoid, meningitis, and all the dark brood of the zymotics. It is a great gain to have it known that the geological formation of the ground is a most important sanitary factor; and each year, as the attention of people about to erect houses is turned to it, there are more and more who are capable of forming an intelligent opinion on the matter. The faithful wife and mother will look at her husband and children, and will say, "You are of far more value than all the fashion in the world." Even on the extreme supposition that the choice is restricted to a very limited area, a careful attention to the construction of the cellar will go far to antagonize unfavorable conditions.

Cellars of City Houses.—Here is a field for vigilance indeed! Even if one were able to take geological formation into account, it would require a princely revenue to pay for the investigations needed to ascertain it. As to the superincumbent strata, how many of us remember the high-graded streets and avenues of growing cities—the deep, oblong chasms between, the dumping ground of all the adjacent neighborhood, with alternating strata of dead cats and tomato-cans; of old boots, and coal-ashes, and garbage of all sorts? In wet seasons the water stands green and stagnant, making all into a true witch-broth. This, in the season of financial depression, when the canny real-estate man "buys in." The commercial tide turns, building-lots are in demand, the witch-broth has never "leached" off, but

those chasms are known to hold "the potentiality of wealth beyond the dreams of avarice," as Dr. Johnson said of Thrale's breweries. So, presto! a busy procession of gravel-carts soon changes the cat-conglomerate into "the most desirable building-lots in the city, unsurpassed for location." They look innocent enough, though we have not yet named what may be the deadliest element of their "conglomerate," i. e., the leakings from ill-made or broken sewers. The least measure of self-preservation one can take is to have an impervious cellar, bottom and sides, if one is resolved to build on one of the "unsurpassed"—it is costly, but doctors' and apothecaries' bills are more costly. The case is exactly analogous to the putting on of a rubber boot in crossing deep mud: it keeps the moisture and filth out. There is nothing more difficult to comprehend in the one case than in the other; but, while the muddy street would cause only a temporary discomfort, the barefooted house is to suffer from the miasmatic exhalations of the cat-and-garbage mixture, night and day, year in and year out.

The mistress of the mansion can not be too strenuous in urging her husband, or directing her architect, not to use the pernicious economy of inadequate foundation-walls. Some of the sanitary mischiefs that come from a "settle" of an inch are almost irreparable, while the cost of repairing those that can be remedied will far outweigh the difference between slight and solid foundation-walls. Then, however carefully one may build his own house, he never knows how much ignorance or carelessness may live next door. An apathetic neighbor can often neutralize the most careful sanitation, for in this matter "none of us liveth or dieth to himself."

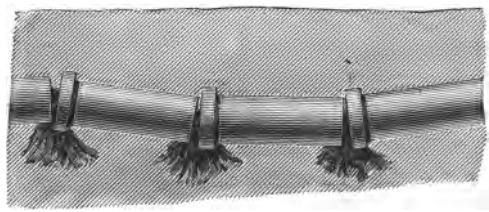


FIG. 1.—Drain in made land, settled. ("Sanitary Engineer.")

A few years ago a Boston gentleman inherited a house, situated on one of the most desirable streets of the city. Resolving to make a healthy as well as a beautiful home, he spent a large sum, and gave personal supervision to all the details of an elaborate system of plumbing, having first diligently studied up the subject. He moved in. Imagine his grief and disappointment when member after member of his family succumbed to diphtheria, and an infant and a grown daughter died. Though so deeply smitten, he didn't lose his belief in the connection between cause and effect. He ordered a minute investigation of the premises by experts: a slight crack, so small as to have escaped ordinary observation, was found in the cellar wall. Investigation of the premises next door — the inmates of which were also suffering from diphtheria—showed a choked-up drain, which ought to have connected with the sewer but did not. The filthy ooze from this was pouring out, just where its effluvium and its disease-germs could pass without any hindrance, through the crack. Now that it is

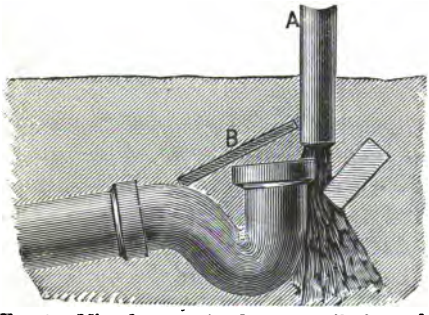


FIG. 2.—Missed connection between soil-pipe and trap. ("Sanitary Engineer.")

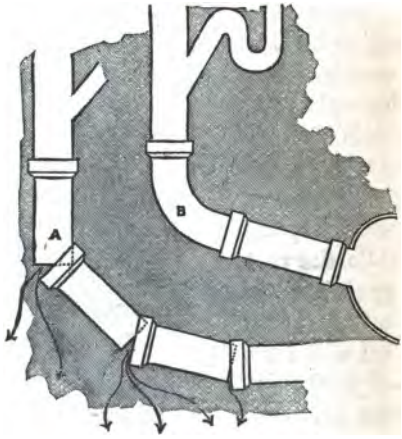


FIG. 3.—Curve formed of straight lengths of pipe.

shown that gases pass through bricks and many kinds of stone, it is easy to see that the sanitary welfare of one is the sanitary welfare of all.

Professor Fleeming Jenkin says, "The number and causes of a disconnection between drain and sewer are incredible, to one who has not seen them." Sometimes the drains run "up hill" —cases have been found where they have been carried up over a sharp curve, to save the "jerry" builder the cost of blasting out the underlying rock, while in Halifax a case was found where the drain left off just outside the house against a solid rock, and farther on the farce was completed by laying a strip of pipe in alignment with this to a perfectly useless cess-pool, with the result, reported by the family doctor, "children always ailing."

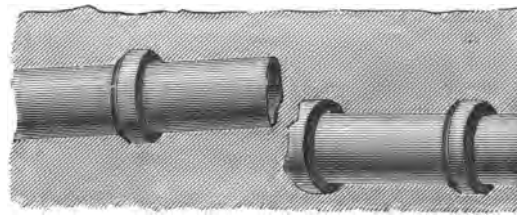


FIG. 4.—Earthen pipe with socket broken off, and next length so deflected as to render it useless. ("Sanitary Engineer.")

Every one of these illustrations contains the record of a fact, and there are hundreds of others just as graphic. Generally the disconnection is just at the junction of the soil-pipe and the drain (Fig. 2), and of course the filthy soakage infects the soil nearest the wall of the house, and Mr. Elliot C. Clarke says that when tested with oil of peppermint, here is the point where, in a majority of cases, its tell-tale odor will be perceived.

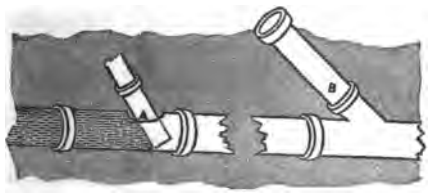


FIG. 5.—*A*. Badly made junction. *B*. Proper junction.

The accidents that come from lumps of mortar dropped and left on the bottom of brick drains, and the projection into iron drains of solder, which of course "dams up" the sewage, are plentiful, and this illustration shows another type of "scamping." No cellar can be sweet with such a neighbor as this.

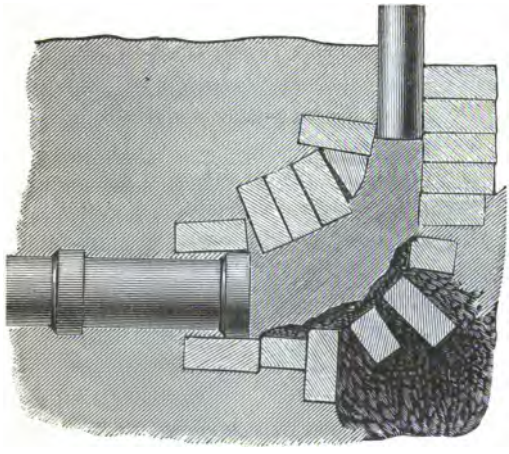


FIG. 6.—Drain, with junction made of bricks. ("Sanitary Engineer.")

Old Country Houses with Wet Cellars.—But the majority of people live in houses already built—purchased or inherited homes—many of them erected before the present era of sanitary enlightenment set in. The best they can do is to remedy existing evils, as far as possible, and one of the most glaring and health-destroying is indicated in the title of this paragraph.

In 1873 Mr. Henry F. French, then of Concord, Massachusetts, and since of Washington, D. C., prepared an article in answer to the request of the Massachusetts Board of Health on "Drainage for Health." It was an article of singular merit, written by a man who was already a high and recognized authority on this theme. Brief, explicit in its directions as to how to achieve the purpose in hand *with a small outlay of money*, it was worthy of being distributed as a sanitary tract, through the length and breadth of the land, to millions of Americans who are to-day living over just such cellars as he describes. If there is any class who suffer from the accumulated horrors of these "black holes," and are interested in their reformation, it is the

women, who, for the largest part of the twenty-four hours, must breathe the vapors generated in them. How many can recall with shuddering horror the pasty, sticky cellar-bottom that must be traversed to reach the potato-bin, or even the aristocratic wine-cellar! This preface is the only apology we make for transferring bodily Mr. French's paragraphs on "How to Drain Cellars," hoping that we are thereby putting them where "they will do the most good."

"Did the reader ever, when a child, see the cellar afloat at some old home in the country! You creep part way down the cellar stairs with only the light of a single tallow-candle, and behold by its dim glimmer an expanse of dark water, boundless as the sea. On its surface, in dire confusion, float barrels and boxes, butter-firkins and wash-tubs, boards, planks, hoops and staves without number, interspersed with apples, turnips, and cabbages, while half-drowned rats and mice, scrambling up the stair-way for dear life, drive you affrighted back to the kitchen.

"In a large proportion of the houses in some old villages in Massachusetts (and in other States as well) there is no provision whatever for any drainage of the cellar, and in thousands of houses the water, as often as once in three or four years, covers the cellar-bottom, sometimes to the depth of two or three feet, and remains several weeks, gradually settling away as the general water-table of the town is drawn down by the subsidence of the freshet. In sandy plains the water lies usually nearly level, with a slight inclination toward some stream or pond or swamp, into which it slowly percolates through the ground. The water will, in such cases, be found at about the same level in all the wells and cellars. It rises in them as the ground is filled precisely as it rises in a well.

"In soils with a bottom of clay or hard-pan, slowly pervious to water, it will often pond in the cellar when far from the surface in wells near by. The great spring rains, with melting snow, have not time to soak down through the close soil, and the water seeks the nearest outlet from the overcharged soil, and finds it in the cellar, the bottom of which is too compact to allow its escape as fast as it enters.

"Now consider the case of one of these old farm-house cellars that has been in use fifty years or more. In it have been stored all the potatoes, turnips, cabbages, onions, and other vegetables for family use. The milk and cream, the pork and beef, and cider and vinegar, have all met with various accidents, and from time to time have had their juices, in various stages of decay, absorbed by the soil of the cellar-bottom. The cats, so neat and peculiar in their habits, have slept there to fight the rats and mice, who have had their little homes behind the walls for half a century, and the sink-spouts have for the same term poured into the soil close by their fragrant fluids. The water rushes upward and sideways into the cellar, forming, with the savory ingredients at which we have delicately hinted, a sort of broth, quite thin and watery at first, but growing thicker as the water slowly subsides and leaves its grosser parts pervading the surface of the earth, walls, and partitions, and the floors above, fully saturated. All this time the air rushes in at the openings of the cellar, and presses constantly upward, often lifting the carpets from the floors, and is breathed day and night by all who dwell in the house. Does it require learned doctors or boards of health to inform any rational person that these conditions are unfavorable to health?

"The most common method of draining a cellar of a New England country house is to construct a small stone culvert, running from the lowest corner of the cellar to some low place a few rods distant, and digging little trenches across the cellar-bottom in various directions leading to this outlet.

"This is expensive and very imperfect, though better than nothing, as the water can not rise so long as the drain remains open. Such a drain, having a flat bottom, and admitting floating particles of wood or vegetables, readily clogs, and it only removes water which is above the surface, leaving the cellar-bottom muddy, like a highway in the spring-time, and requiring planks and boards to render the path tolerable. Small animals pass through such drains at pleasure, and in one case we knew of a musk-rat being caught foraging in a cellar which he had thus entered.

"The cheapest and the best mode of draining a house-cellar, in most cases, is that adopted by the writer on his own premises in two instances. It is, in fact, a mere application of the ordinary principles of field-drainage.

"The writer purchased a farm in Concord, on which was a house which had been built about seventy-five years. It had no drain whatever, and it seemed to be generally agreed that once in two or three years water had always stood in the cellar, sometimes two feet deep. The occupants had been intelligent, wealthy farmers—two or more generations of the same family—who seemed to understand everything but drainage. Having taken levels, it appeared that a low tract on the opposite side of the highway gave sufficient fall for our purpose. A trench was opened from that point, across the highway, to the nearest corner of the cellar. We tunneled under both walls, and under the roots of very large elm and ash trees, and under the cellar-wall, going about four feet deep, except near the house, where we went nine feet deep. The subsoil all the way was sand, very easily moved. In the cellar the drain was continued around the big chimney in the middle, to the farthest corner, about one foot below the surface. In the cellar were laid common two-inch drain-tiles, to the corner where the drain goes out under the wall. There three-inch tiles were used across the street about one hundred and seventy-five feet; then, as the soil was springy, four-inch tiles were used fifty-eight feet more to the outlet. The joints were covered with tarred paper, exactly as in the field-drainage, and the soil was returned and leveled, the outlet was secured by a little wall of stone, and a copper netting was put over the last tile, and the work was done. Let it be understood distinctly that the drain is covered all the way. There is no opening in it except the grated outlet. There is no place where a mouse or even a fly could enter. The air can not draw through it except as it passes up through a foot of earth. It was laid in November, 1867, and in the same season a furnace was put in, with its ash-box level with the cellar-bottom. The tiles for the two hundred and thirty-three feet cost $10.86, and the labor $10.50; in all,

$21.36. This was the whole cost of what appeared to be a great work, except the small tiles and labor in the cellar—not more than would make the whole cost $25. The result is, that there has never been a drop of water visible in the cellar, although the spring of 1870 was one of the wettest seasons known, and many cellars in Concord were flooded. In May, 1868, by careful measurement, the water in a well within twelve feet of this cellar was two feet above the tiles in the cellar-bottom, the four-inch pipe running two-thirds full at the outlet, yet the small pipes in the cellar were sufficient to keep down the water, which in old times would have covered the cellar-bottom a foot deep. A cellar in Exeter, New Hampshire, drained in precisely the same way twenty-two years ago, has been perfectly dry ever since, without any attention whatever being given to the drain, which will probably be as lasting as the house itself."

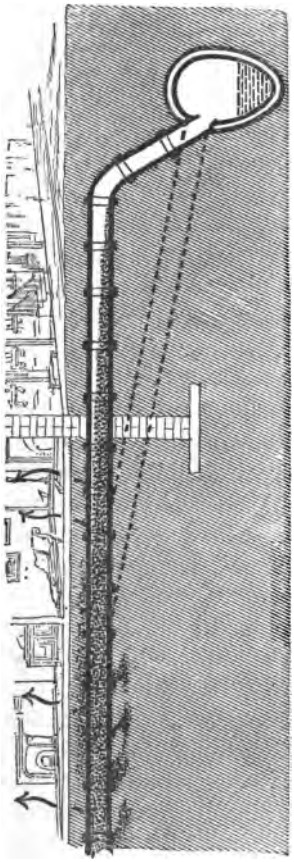


FIG. 7.—Economy in digging, at expense of fall.

Mr. French continues: "Often buildings are placed on the slope of a hillside, having a subsoil not readily permeable by water. In its natural state the surface-soil may be open enough to be sufficiently dry for cultivation, as the water from rains in the growing season may pass downward out of the way, and run off upon the underlying stratum. But a cellar is sunk four or five feet and stoned

up, and forms a reservoir, which catches the water flowing in the soil, and holds it for weeks or months, until it passes slowly downward. In such a case it is often practicable to catch the water before it enters the cellar, and so avoid all dampness by running drains on one or more sides of the building outside the wall."

As consulting engineer he cured one of the public institutions in Massachusetts of a drowned-out basement dining-room at a cost of about twenty dollars.

He further says: "The idea of cementing the floor and inside of the walls of a cellar or basement is very common. The pressure of water is in proportion to its height or head, without reference to the extent of its surface. If, then, the water be heaped up behind a cellar-wall to the surface, we have a pressure equal to that of a mill-pond against its dam seven or eight feet high. No sane man would think of tightening a dam of that height by plastering the down-stream side of it with cement. We have seen one instance where a cellar was carefully and heavily cemented to exclude water, and the pressure of the water lifted the whole body of the cement from the bottom, leaving it in broken masses, like flagstones half on edge. It is certainly practicable to exclude water from a cellar by a heavy wall laid in cement, and a heavy cemented floor of brick or stone, but the process is very expensive, and leaves the adjacent soil saturated with water in wet times."

In making any drains for any purposes care must be taken that the slope is sufficient, or we get a result like this, Fig. 7; and when laying pipes in wet soil the joints need to be united by impervious cement to prevent the entrance of willow-roots. It is simply amazing from what a distance a willow-root will "feel in its bones" that there is a congenial feeding-ground in a drain-pipe that is within its reach; it will send in one fine filament after another, till it has pried the joints apart and wholly blocked the pipe. The illustration shows a large mass of willow-roots that had blocked a Milwaukee sewer, and the gentleman who communicated it to the "Sanitary Engineer" calls it a "curious freak of Nature." It is a very common

occurrence, as any one will find by conversing with people at all familiar with drains laid with uncemented joints. Hardly one of them but will relate at least one instance that has come under his own observation, and, unfortunately, the trick is not wholly confined to willow-trees.

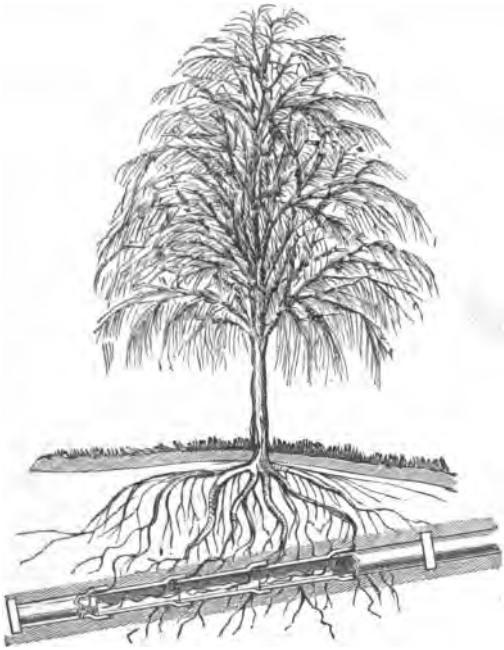


Fig. 8.—Willow-roots penetrating a drain laid without cemented joints. ("Sanitary Engineer.")

Cellars of Small Country Houses.—A woman can attend to it that the cellar of a house too cheap to have even a cement bottom has windows, on opposite sides if possible; if not, on different sides; grated to keep out animals, and opened to insure ventilation and cross-currents of air in the summer time. Even if living in a rented tenement, whose owner has omitted this arrangement—which would keep the sills from rotting, if he did but know it—a frequent opening of the cellar-door would purify the air beneath the house, and prevent the up-draught of material that has proved the parent of illnesses of many kinds, as is conclusively shown in the collected reports of the various boards of health.

Large Country Houses.—In these, where the warming is to be done by a furnace, or by a massive hot-air or steam appa-

ratus, there will be a positive current of warmed air rising through floors and cracks, bearing along whatever elements are found on or are drawn up through the cellar-bottom—as nobody has yet succeeded in building a hermetically sealed house. Here the need for an impervious floor is greater. Asphalt is best; good cement next best. If a furnace is used, there will be a cold-air box, and the hot-air pipes, and the smoke-pipe; and if the town has a pipe-supply of water, there will be added another bewildering complication for the distribution of hot and cold water. Gas and drain pipes add a myriad more, and all these need to be in plain sight, and painted of a color so light that leaks, either from age, defective original construction, or "settling," may at once proclaim and betray themselves. It would be an unseemly omission not to have an impervious cellar-bottom here. A house equipped with all the appliances that we group as "modern conveniences," in their simplest forms, is a complicated machine, or rather a congeries of machines, but not at all incomprehensible. In this day of alleged progress, when women are clamoring for admission to colleges, and are passing examinations for this and that "annex," it behooves the housekeepers of the period to utilize their intellectual powers in mastering some of the mechanical and scientific laws that underlie these comforts.

It requires but slight knowledge to perceive why it is important in a huge country cellar, filled with vegetables for a six months' supply for a large family, that some ventilating shaft should be provided to carry off the effluvium from the ceaseless chemical action directly to the outer air. The mistress should know just what sort of neglect, in a zero night, will cause the kitchen-range to explode, and understand why it is better for the intake of the cold-air box to be from a clean inner court than from a crowded and dirty street; in short, in studying, and comprehending, and ruling a scientifically-built house she will find scope for thought and study, and then, when she learns to defend her family from the many preventible diseases, she never will need to "stagnate," or complain of *ennui*. Dr. Richardson, in his enthusiasm, says: "For

women, the grand idea of preventive medicine inaugurates a new life."

Clean Cellars.—Though out of sight, a filthy and neglected cellar will, sooner or later, bring itself to mind. Fungi and molds will grow in the crevices and from the walls. The use of a thorough coat of lime-whitewash, once a year, will destroy these. The fashion of often washing them down with clear water, and leaving the damp walls to dry by evaporation, should be discouraged. The dampness is in itself deleterious, and before it dries, the spores of fungi will sprout, and fructify, and produce countless others. These always militate against health.

The presence of decaying vegetables in the cellars of country houses is so often a concomitant of typhoid fever that when, in 1871, Dr. Derby asked the doctors in Massachusetts, "Do you believe that putrid and rotting vegetables or foul drains produce typhoid fever?" ninety out of one hundred and sixty-three gave an unqualified "Yes."

But it is not alone in the farm-houses and dwellings, where the hands are few and the labors to be performed are many, that these fatal neglects occur. On one of the most fashionable streets of New York—a few doors from Fifth Avenue—a house which had cost $40,000 to build, and which was furnished correspondingly, was found to be in the hands of a real-estate agent, "to let." Whatever the ostensible reason, the real thing that was driving a man and the surviving members of his family from a beautiful home, that it had been the pride of his life to create, was, that it seemed haunted by sickness and death. For three years there had hardly been a time when all the members of the family were well. Two had died, one from cerebro-spinal meningitis and one from diphtheria, and as a last means of escape from what seemed a fate, it was decided to go elsewhere. A New England woman, whom fortune had frowned upon, was looking for a house in which to conduct a boarding-house. She meant to know just what kind of cellar there was, and what kind of furnace had been put in. As the cellar-door was opened for her explorations a sickening

smell assailed her. In a dark corner of it there was a pile of rubbish—boards that had been used in "boxing," and superannuated household utensils, mingled with an occasional decayed potato, etc.; but the stench was so strong that she suspected a broken drain, and insisted on seeing the bottom of the pile. After literal loads of mingled rubbish had been lifted, among which were many old mildewed sponges, rags, shoes, and single vegetables, a barrel was reached in a state of stench and decay that can not be described. It had been full of turnips, sent as a gift from a "fancy-farmer friend" to the owner, long before. The family were not fond of this esculent; so that after one dish had been cooked, out of compliment to the donor, the remainder had been left and forgotten, and formed the malignant nucleus of a poison-heap. Some of the old boards were in a state of dry rot, and there is a stage in the decay of wood that develops a fatal fungus. This was in a "mansion," where a complete corps of servants, from footman and lady's maid down to scullery-girl, was kept. The mistress had never been in the cellar. The master had been almost as careless. He only went when the furnace indulged in an apathetic spasm on a zero night. Unintelligent and shirking hirelings had been expected to render a service to which they were wholly incompetent. The house was leased for five years, was cleansed as only a Yankee woman can clean, no filth-disease of any kind came to any of its numerous inmates, and at last the proprietor, a sadder and wiser man (for he now studied sanitation), returned to it, convinced that direct neglect had been the cause of what once would have been called a "mysterious visitation of Providence." The mistress of the house never drank a glass of water without holding it up to the light to detect visible impurities. It never occurred to her to investigate the vital air she was hourly breathing.

Professor C. F. Chandler, who, as expert sanitarian at the head of the health board of New York city, has probably examined more cellars than any other individual in America during the last six years, says, "Ninety per cent of the cellars in the city are unwholesome"; and Mr. C. F. Wingate, an

expert sanitary engineer of high standing, echoes the statement. A tight, unventilated cellar, and what takes place in it, is well illustrated by the following: A large tin coffee-pot was emptied, washed and drained, and left open till it *seemed* dry. It was then shut up and left on an ordinary kitchen-dresser for a week, when, on looking at it, there were all along the seam at the bottom spots, at intervals, of a silver-colored mold, each radiating from a tiny central point, where, of course, a particle of organic matter (coffee) had been left, and by shutting down the lid, and thus making an unventilated space, the moist coffee had produced its little forest of *penicilium*, or some other type of microscopical mold. No such appearance would have been presented if the lid had chanced to be left open.

If the reader thinks we are "staying down cellar" too long, the answer is, that is the vital portion of a truly sanitary house —if it is faulty, no amount of care above the ground-floor can neutralize its evil effects. Professor Chandler advises every householder to inspect his cellar at least once a month, but as this is addressed to women, a little anecdote of a German bride will not be amiss. She was full of womanly ambition to be a good housewife, and she had a wise father. Among his wedding gifts he bestowed a small but exquisitely beautiful golden casket, which he charged her on no account to intrust to other hands, "for," said he, "it holds a precious charm against many of the evils that inexperienced housewives have to contend against. You are to use it by taking it every morning to the kitchen, the cellar, and the stable, and setting it down in each for three minutes. You will have to remain by it, for the magic will not work otherwise; it has a mysterious connection with you alone. At the end of three years you may open the casket (I shall send you the key on the third anniversary of your wedding-day), for then it will have done you all the good it can." When opened, its sole contents were a little strip of parchment, on which was written, "*The eye of the mistress is worth a hundred pairs of servants' hands*"—and he felt that a habit of three years' standing might be left to perpetuate itself. A daily three-minutes' visit to the cellar would

be a grand beginning for the woman resolved to do her whole sanitary duty. Eternal vigilance is the price of everything worth the having or the keeping.

Sleeping in Basements.—There are a great many ways of asking Cain's question, "Am I my brother's keeper?" and altogether too many of essentially repeating his course toward Abel. The sanitary light of the present day has penetrated to the worst and wettest of the cellars in the "horrid" quarters of our cities, and these disease-breeding dens have been cleared of their tenants; but higher up in the scale, and in quarters where external elegance forbids the suspicion, there are hundreds of servants sleeping in half-basements and basements, that have no impervious shield of asphalt to shut out the ground-air and its poisons; and here ague, rheumatism, and consumption are silently sowing their deadly seeds. All sanitary authorities agree in forbidding sleeping at the level of the ground; what, then, shall be said of putting our unfortunate brother, whose health and strength is his whole capital, into a crypt, but a degree better than the one he will occupy when his toils and privations are over?

Sir Culling Eardly, who lives in Erith, on the borders of the marshes which Dickens has described as "Dumble-down-dreary" in one of his graphic sketches, testified: "My house is protected from the height of its position, but even in my house we have the ague; and to show the extraordinary manner in which the ague operates: in the basement story of this house, where my men-servants sleep, we have more than once had bad ague; in the attics of my house, where my maid-servants sleep, we have never had it."

CHAPTER III.

ARRANGEMENT OF THE HOUSE.

Material of the House.—The vast majority of American country houses will, for the next century at least, continue to be made of wood—a material that lends itself easily to sanitation—on account of its abundance and cheapness. Where taste dictates the employment of brick or stone, the mistress should not let an efficient "damp-course" be forgotten, to exclude the capillary moisture of brick, and frequent airings are needed to counteract the condensed moisture of stone; but the selection of the materials of a house is an important matter that is not in danger of being slighted; the cardinal rule is, *the house must be dry*, from cellar to attic, for dampness serves as a medium for any decomposing matter that may be evolved.

Location of Living-Rooms.—The father and mother of a young family, full of enlightened sanitary zeal, were planning a new house. They said the first insurmountable difficulty they met was "that all the rooms could not be on the south side." True; but by judicious planning, and a vivid sense of "the more sunshine the more health," they reduced the difficulty to a minimum. The nursery was so arranged as to get the sunshine morning, noon, and night. Every sleeping-room got it in some part of the day; even the rarely-to-be-used guest-chamber on the north side got some reflected light thrown in at an angle from a portion of the side-wall. The entrance-hall was on the north, and also the dining-room, though this was amply lighted by large windows; but the mother wisely decided that the living-room, where she and the children were to spend many hours, and the library that constituted papa's sanctum, must not be sacrificed to a room where meals were to

occupy but a relatively short time, and where artificial light during many months supplied the illumination and cheerfulness. A judiciously planned bay-window aided in throwing light where it could not otherwise reach. Thus the home-rooms were on the sunny side, while the formal drawing-room had to content itself with being half-and-half. As to the "dark" rooms in the long and narrow city houses, where no ray of honest sunshine ever comes, the sanitarian knows them for an utter abomination. There are thousands and thousands of them in the old houses, and it requires all the authority and vigilance of an alert health board to keep greed from evading the laws against them in new buildings. The boarding-house keeper who said, "I notice that the boarders who take the dark rooms *bleach right out*," spoke more wisely than she knew, and tersely expressed the effects of a process that the chemist comprehends without further comment. The Italians have a proverb, "When you let the sunshine in you drive the doctor out."

Of course, all sleeping-rooms should be above the ground-floor. To many people this seems a most uncomfortable arrangement, but as the true nature and mode of action of miasma come to be better understood, all over the ague-producing districts of the West and South there will be a general movement "up-stairs to sleep"—literally *steps* in the right direction. The objection to doing this would be half abolished if a little more consideration and intelligent thought were given to the construction of stairs.

Stairs.—Going up stairs is a question of lifting a certain weight through a certain distance, by a succession of muscular impulses, and the ease or difficulty of the process depends on the "pitch" of the stairs—i. e., the relative height and width of the treads and risers. There is a staircase in Massachusetts over which a succession of nurses—in attendance upon a chronic invalid, whose wants necessitated a perpetual going up and down—were compelled to travel many hundreds of miles. Their unanimous testimony was, "I never saw, before, such an easy flight of stairs." Here are the exact measurements: They have seven and one eighth inches of rise, and ten and a half

inches of run, without reckoning the "nosing"—a projection on the front edge of the tread of from one to one and a half inch. There is a landing about three quarters of the way up—and it is a great advantage to have a landing—the nearer the middle of the flight the better; and, luckily, architects are discovering the beauty as well as compactness of such an arrangement. At the landing the climber unconsciously takes in a reinforcement to his breath, and reaches the top, not in a state of panting exhaustion, but comparatively fresh.

There may be emergencies in a household, especially in those sections where domestic help is hard to get, where in severe illness or accident a person had best be placed on a first floor, to save steps; but this is a compromise, a choosing the lesser of two evils, and should not be tolerated as a permanent arrangement.

Elevators in City Apartment-Houses.—We confidently look for the extinction of some forms of disease to be wrought by the use of the perpendicular railway. The apartment-house in its present stage of development is far from being satisfactory, but one of its indisputable advantages is the saving of muscular power and vital force effected by this great conservator of breath and strength.

Shut-up Rooms.—Having planned to give the rooms the life-giving light, see to it that every one which is to be occupied at night is opened so as to get an unobstructed flood of it during the sunniest part of the day. The murmur comes back, "It will fade your carpets"; very likely, but carpets were made for people and not people for carpets, and any right-minded mother would prefer to see the roses on her children's cheeks than on her carpets, when it comes to a choice between them. There are many houses, occupied by people too busy to use a parlor, where the sunniest corner is occupied by an unopened, unused, "best room," which is only the survival of a traditional belief that no house is complete without one. The interest of the money on the carpet and furniture would pay for the services of a stout maid during many of the severest weeks of the year; the room is the expression of a yearning

for and a dream of leisure that never comes ; far better have the reality of aid to lighten household duties, that are much too heavy in all the newer and poorer sections of our land.

A protected Place for the Drying of Clothes.—No census-taker will ever give us the count of the multitude of women who annually "take their death-cold" in connection with the weekly wash. There should always be provided, either in the attic of the main house or in the space over the wood-house, a sheltered place for the drying of clothes in stormy or cold weather. Many a pneumonia or fatal lung-fever or cold, which sowed the seeds of a more remotely deadly consumption, has been contracted by going from a heated room and a steaming wash-tub into a zero atmosphere, with the feet on the frozen ground, to hang clothes, or by handling them when frozen, to rescue them from some impending storm. "But the clothes are so much whiter, dried in the open air," argues the over-nice housekeeper ; possibly, but then who could bear the dark stain on the soul of knowingly sacrificing her own health or that of her servants to a trivial difference in the shade of garments?

Warming and Ventilation.—When so eminent a sanitarian and scientist as Dr. John T. Billings, surgeon of the United States Army, and who, it is safe to say, knows more than any other man in America on the subject, employs his pen in a series of forty-two articles in the "Sanitary Engineer," * to set forth his views on these twin themes, it is perhaps not becoming in less instructed persons to dogmatize ; but there are a few fundamental principles that are clearly established—admitted without a demur by everybody.

If every occupied room in every house could be maintained every moment at exactly the healthful temperature, with a constant, imperceptible introduction of fresh, unbreathed, perfectly oxygenated air, and an equally unintermitted withdrawal of air which, having passed through our lungs once, has served its purpose and is thenceforward more or less a poison to human beings, the ideal condition would be attained—easy to formulate in words, but difficult to realize in fact.

* "Letters to a Young Architect on Ventilation and Heating."

Says Dr. Derby: "Fresh air is the great natural disinfectant, antiseptic, and purifier, and not to be compared for a moment with any artificial contrivance. There is plenty of it in the world, yet, disguise the fact as we may, there is no getting over the unwelcome truth that, to provide it in abundance in our climate is expensive, since during seven months of the year it must be artificially warmed. To take in air at the average winter temperature of 28°, raise it to 68°, and discharge it again from our houses even once in an hour, is a process which can not be accomplished without paying roundly; yet on no other condition can we reasonably expect health and long life. The best way is to freely admit that it is expensive, but worth the money it costs. If Benjamin Franklin thought that 'a penny saved is a penny earned,' he was also equally sure that 'health is wealth.' Instead of asking ourselves, With how little fuel can I warm my house, by stopping the flues and the beneficent window-cracks which the carpenters have left? the question should be, How much can I *afford to pay* for fresh supplies of pure air, moderately and equally warmed, and distributed without waste? I can not help believing that the sum of family health and happiness in a generation would be more increased by *liberal expenditures for this purpose than for any other*. But even if we are willing to pay for it, efficient ventilation is not always to be had, and here the builders and architects are to a great degree responsible. It is not surprising that this should be the case. Architecture was a full-grown art two thousand years ago; ventilation is modern. It is only a century since oxygen was discovered. Fifty years ago the physiology of respiration was not understood. The agency of foul and putrid air, filled with decomposing material, in causing disease, is a very recent discovery, yet nothing is better established."

Out of the sufferings of the Crimean war came the revelation, through Florence Nightingale, of how much *intelligent* nursing increases the chances of life in the sick and wounded; out of our own war of the rebellion the equally beneficent proof of perfect cleanliness, maintained by vigorous "policing,"

and of unvitiated air as remedial agents in disease—demonstrated by the hospital tent. It revolutionized the notions of even progressive physicians as to the amount of air each individual can taint and spoil for further usefulness, and much thought has been expended in devising costly and ingenious "systems of ventilation"—too often failures—for public buildings, and many of the more expensive class of private houses have been furnished with ventilators to be soon discarded.

An exhaustive study of the highest authorities brings out the fact that, as yet, no means of ventilation has been invented or discovered that equals a shaft, or flue, or chimney of ample size and well *heated*. Even a small lamp on the hearth will serve to put in motion a column of heated air upward. The penny-wise economist exclaims, "The heated shaft will carry off three quarters of the heat." True; but it is the price of health. Dr. Billings says, no scheme has yet been devised by which heating, ventilation, and economy have been combined—using economy in its ordinary sense of "money-saving."

In elegant, first-class houses, there will be a general provision for warming made, no doubt, by furnace, steam, or hot water, for the entire establishment, while open fire-places, with their attractive cheer, will supply the ventilation; but the large majority—the million—will still depend wholly on stoves or furnaces. Every day these are more intelligently made. The old-fashioned sheet-iron, "air-tight," that burned all the vitality out of the air in a twinkling, was only a milder type of infernal machine. Our ancestors were roasted in front and frozen behind at the open mouth of a chimney, that was all ventilation and no warmth. The scientifically constructed base-burning coal-stove, in which the fire can be lighted once for all in the autumn, and which diffuses a gentle warmth all through a small house, is an unspeakable advance on all that have preceded it. With the advance of hygienic knowledge and the progress of ceramic art in America, we look to see an American porcelain stove, that will transform the forests and coal-beds of the country into as healthful and delightful a source

of warmth as those that excite the raptures of travelers in Russia, where contending against a bitter climate for thousands of years has accumulated a vast and rich experience.

There is one source of ventilation that is so familiar and obvious that it is often forgotten or neglected: it is simply opening common windows, especially when a room is to be unoccupied for a short time; then, when a draught will harm no one, the air of the room can be wholly renewed in a few minutes. This is not to be done on a zero day, for, though "foul air is a slow poison," a blast of cold air may slay like a sword.

> "If the wind strikes you through a hole,
> Go count your beads and mind your soul,"

says the old proverb; and one of the most familiar facts is the connection between draughts and colds.

Sleeping-Rooms ought to be Moderately Warmed.—To the student of physiology nothing is more striking than the gentle and imperceptible gradations by which Nature conducts most of her processes. Violent contrasts she seems to abhor. One prolific source of winter lung-troubles is as follows: On a bitter winter's night the family are gathered round a glowing stove; very likely the crevices round the windows are calked with rags to prevent any ingress of air. The temperature is 90°. With shrinking reluctance the youngsters look forward to going to bed in rooms where the walls glitter with frost-sparkles, and the windows are closely curtained with sheets of frozen moisture. Anybody who has taken that awful first plunge into a bed as cold as a morgue-slab, and lain awake for an hour with his teeth chattering and every fiber quivering with cold, will realize that the warming-pans of our grandmothers had worthy uses, and will mourn, with reason, that they have passed out of fashion. Of course, the persons who had been sitting by the stove, in the calked-up room, were perspiring freely when they left it, and the violent change of temperature, with the unavoidable exposure of undressing, would cause an instant check, in nine cases out of ten, sufficient to produce a cold, while in delicate constitutions and at critical

periods it is quite enough to lay the foundation of incurable maladies.

There are people, intelligent enough about some things, who think all this painstaking about fresh air is superfluous nonsense ; they will echo Mr. Trevelyan's rhymes about John Bull of a former generation :

"We much revere our sires, who were a famous race of men ;
For every glass of port we drink, they nothing thought of ten ;
They lived above the foulest drains, they breathed the closest air,
They had their weekly twinge of gout, and nothing seemed to care.

"Although they knew not dry champagne, nor got their ice from Wenham,
They played the man before Quebec and stormed the lines of Blenheim ;
They never stopped to count the risk or sum the money spent,
But clinched their teeth and straight ahead with sword and musket went."

They will tell you that our grandfathers lived longer than we do, and were "tougher" every way. Our ancestors *did not live* as long as we do ; only those who were born tough lived to old age at all. They imagined that hardships were wholesome, and that it made a man effeminate to be comfortable ; but, thanks to the labors of sanitarians, it is being daily demonstrated that "*comfort*"—complete physical satisfaction—is but another name for high health, and every advance in it, is a step toward long life.

Transoms over Sleeping-Room Doors.—One of the simplest and least expensive additions to comfortable ventilation is a transom over the door of each sleeping-room. By holding a taper near one of these openings it will be seen to waver, showing that there is a current, for it is impossible to maintain exactly the same degree of temperature on both sides of it : of course, there is a certain space where there is no stagnation of the air, with its consequent liability of being rebreathed.

Arsenical Wall-Papers.—Among the substances used to produce colors on some of the most attractive paper-hangings, are

Scheele's green, which contains fifty-five per cent, and Schweinfürt green, which contains fifty-eight per cent of white arsenic, that everybody knows as a deadly poison. They produce a pure and bright green, most alluring to the eye, and are so cheaply produced as to be most alluring to the manufacturer also.

In one class of goods the pigment is so loosely applied as to be removed with the slightest friction; in the glazed papers the danger is less, as the glazing forms a barrier to its ready removal, and the "flocked" or "velvet" papers hold an intermediate place in point of danger to health. The "Report of the Massachusetts Board of Health" for 1872 exhibits two specimens, one of which has 5·42 grains and the other 29·32 grains of arsenic to the square foot, so that a room of ordinary dimensions, decorated with arsenical paper-hangings, would hold on its walls more than half a pound of arsenic.

But the important question is, Does the presence of this pigment in papers harm the occupiers of the rooms where they are used? Can a substance which we know is poisonous when swallowed be so detached from these walls as to contaminate the air enough to produce injury? Decidedly, yes! In some cases it has been known to be fatal; in more it has caused a long train of invalid symptoms, more or less pronounced, varying with the idiosyncrasies of the individual, the quantity of poison in the room, and the number of hours it is occupied. The interested manufacturer will say, "Stuff! moonshine! some of the healthiest persons I ever knew lived in rooms hung with arsenical paper"; and the fascinated feminine admirer of some "love of a paper" will say, "It is too pretty to be discarded, and I can not believe it does harm; else, why do we not hear more about people who have been killed by it?" Few are *killed* by it, but there are plenty of people who have endured all the phases of chronic arsenical poisoning, without suspecting the nature of the root of their trouble until the scientific physician has appeared with his test-tube and scales, and has demonstrated the cause. One uniform feature runs through all the recorded cases: the subjects at once improved

on being sent to some new place, and at once relapsed on ing to their old quarters, unless, meantime, their walls ha stripped and rehung with a safe though less "charming" article. There are numbers of instances where paper-hangers and paper-makers have been afflicted; also women who work on, and women who wear arsenic-green tarlatan dresses, and multitudes of the workers in artificial flowers.

The case of Dr. Halley, of London, is here quoted, as he had the typical arsenical symptoms, and possibly some one will recognize the features of a disorder close at hand. Dr. Halley's library walls had been covered with a newly-made, rich, emerald-green flock-paper. Shortly afterward he commenced to occupy the room regularly every evening for several hours, a single gas-burner supplying the light. After a few days he began to suffer in health; there was constant headache, dryness of the throat and tongue, with internal irritation. After three weeks of this experience, he became completely prostrate, not yet, however, suspecting the cause of his malady. Partial paralysis of the left side supervened. His condition obliged him to discontinue his studies in his library, and, coincident with this intermission, he began to recover; but as soon as he resumed his labors the symptoms recurred. His attention was directed to the wall-paper. It was found to contain nearly sixty grains of Scheele's green to the square foot. The air of the room was likewise tested, and distinct crystals of arsenic were obtained from the dust. The paper was at once removed, and there was no further trouble.

Not every green paper or paint has arsenic in it, and it is not easy to distinguish them by their looks; but chemistry affords a ready test. The suspected green material is to be placed in a solution of ammonia (*aqua ammoniæ*). The chemical substance that produces the green tint is arsenite of copper, and the liquid will acquire a blue tint from the disengagement of the oxide of copper from its combination with the arsenic. If further test be desired, a few drops of the colored ammoniacal solution poured upon crystals of nitrate of silver will leave on the crystals a deposit of yellow arsenite of silver.

CHAPTER IV.

LIGHTING THE HOUSE.

Electric Light.—However deep may be the conviction that the electric light is to be the illuminator of the future, before it can be made manageable and cheap, and adapted to domestic use, there has got to be expended upon it a world of time, and money, and thought, and experiment. The present generation will have to struggle along with their candles, and kerosene, and gas-lights.

Gas-Lights.—These, with their *fixtures*, are probably the safest of any lights yet invented, as far as the liability to accidents to person and property are concerned; but it should not be forgotten that each gas-burner is a great consumer of oxygen, and a great producer of carbonic acid and those other vicious substances which the chemist calls "products of combustion," the atmosphere deteriorating accordingly; while in use they call for the frequent service of all the ventilating appliances at hand, occasionally the simple, direct one of opening a window to renew the air. In some costly private houses, and in many public buildings, there is an efficient and excellent arrangement of a funnel-shaped collector inverted over the burner, and a pipe leading to the outer air; but it is very expensive, and not easy of application to the different apartments of an ordinary house. In fact, the difficulties of using it are formidable, and it will not find general favor; but, while a house is building, it is very easy to have a burner carried to the bottom of a nursery chimney, where it will do double duty as a safe night-lamp, and an initiator to the current of warm upward-moving air that will constantly renew the air of an apartment.

Dangerous Illuminating Oils.—Probably no modern invention, save that of stoves and furnaces, has contributed so much to domestic comfort and home enjoyments as the adaptation of petroleum or rock-oil, through the processes of refining, to the purposes of household illumination. The kerosene-lamp, used under whatever name, is but a portable gas-light; the ultimate chemical elements of both are identical. Solomon said, "Truly, the light is sweet, and a pleasant thing it is for the eye to behold the sun"; had he lived now, he would have added, "and the solar lamp is a perpetual blessing and delight." When the cheerful lamp sheds its vivifying radiance over the family group, they are simply basking in condensed prehistoric sunshine, stored up in countless ages of growth, in gigantic trees and plants, and then reduced to coal and oil by subterranean and subaqueous distillation by the earth's internal fires, after some telluric cataclysm had "banked" them beneath deep superincumbent strata of variously constituted "muds," that were to slowly harden into the substances we call rocks. The crude rock-oil has been known to exist in various parts of the earth for four thousand years, but it remained for America and the nineteenth century "to bring forth all this secret store," and distribute it to the remotest corners of the earth. The first artesian well bored, with the deliberate purpose of "striking oil," which was successful, was made in 1859. The continued production of this substance forms one of the leading features in the commerce of the world; but, in dealing with it, we are face to face with one of the mightiest pent-up forces of Nature—chemical affinity. Our "hand is on the lion's mane."

Ten women fall victims to kerosene accidents to one man, partly because they have the care of the lamps, and partly because nothing will ever deter those who are ignorant of the dangers they incur from "hastening" a fire that obstinately "won't kindle" by pouring on kerosene. The holocaust will continue till some inventive benefactor of mankind produces a safe and speedy means of doing for the fire as a whole what the friction match does for the candle.

One hundred and three fires were caused in New York city alone, in 1880, by kerosene-oil lamps; and of these fifty-four were from "explosions." How needless these were will be clearly understood by what follows. Oil that can be raised to 140° Fahr., before it will give off an inflammable vapor, can be burnt in a lamp, that lamp broken, and only the ignited wick will still burn. But an oil that will ignite at 100° Fahr. will be covered with flames, and will envelop everything it comes in contact with in flame also. The best oils sold in New York give off inflammable vapors at a little above 100° Fahr., and poor people will buy those of much lower grade, for the sake of saving a few cents on the gallon. The true point at which to apply a saving pressure is on the refiners themselves, who should be forced by law, and under severe penalties, to sell only perfectly safe oil.

In order to show exactly where the danger lies in illuminating oils, as used in hundreds of thousands of households in America, liberal use has been made of a lecture on this subject delivered before the Legislature of Michigan, in 1877, by Professor R. C. Kedzie, M. D., who has studied the subject profoundly, and conducted a long series of experiments in that true spirit of scientific inquiry which ever hears above the clamor of interested greed and apathetic ignorance the still small voice, "Truth is mighty and will prevail." Moreover, the history of legislation on this subject in Michigan gives a vivid picture of the forces that boards of health, in their endeavors to save mankind from physical errors of faith and practice, will have to contend against, till an instructed public opinion sides with them in the warfare against selfishness and avarice.

The element of danger in handling the products of petroleum is the volatile vapor that is given off from some of them at a temperature below that of the air; from others, at various degrees of heat; but all of which, under certain conditions, are as inflammable as gunpowder. Kerosene explosions will be better understood by studying the following experience of a man who was, many years ago, making varnish in a large iron caldron over a fire in the open air. When turpentine is

added to boiling varnish, it is followed by violent agitation, and a copious liberation of fumes. This varnish appeared to be "done," and was removed down the hill to the windward of the fire, about two hundred yards. In about a minute after the caldron was set down, the operator thought he would add just another dash of turpentine from the bottle in his hand. He did so. A wreath of white vapor rose up and enveloped the kettle, and also went creeping up the hill, bending and swaying in a very gentle breeze, just as one sees a smoke-wreath yield to alternating currents in the upper air. He was saying to himself, "How curiously that!"—when, flash! it had touched the fire; the vapor made a magic bridge for the flames, and for an instant he seemed enveloped in fire; his varnish was burning. He instantly threw himself on the green grass, but his garments had not ignited. His eyebrows and hair took a long time to grow out again, and from that day on he had a living sense of the inflammability of vapors, even though the source of heat might be a good way from the liquid that was the parent of the vapor.

Says Professor Kedzie, in reference to the law creating the office of State Inspector of Illuminating Oils in Michigan (1875): "Before the enaction of this law you could scarcely take up a daily paper without seeing, 'Another Kerosene Horror!' Since the law has been enforced scarcely a single accident has occurred in the use of kerosene in our State. So complete has been the change that the people are fast forgetting the terrible history of the past, and many are now demanding a retrograde step toward the former conditions of danger. . . . The hand of law with its viewless fingers touches every individual in our State, and, banning or blessing, penetrates every home in the commonwealth. . . . This law, which concerns the quality of a material in daily use in nineteen-twentieths of the homes of our State, becomes a matter of vital importance to a larger number of citizens than almost any law on our statute-books." The question does not alone concern the safety of the family using it, but the community is also interested. If any family in a village uses unsafe oil,

the whole village is endangered. Chicago learned, to her cost, that she had an interest in the quality of kerosene used by her humblest citizens.

In order to understand exactly where the temptation to make and sell and use an oil dangerous to life arises, the reader must, at the risk of some detail, follow a close study of the process and results of "refining" made at the extensive works in Cleveland, Ohio.

Refining consists in separating the complex materials contained in petroleum by distilling and condensing. The crude petroleum is placed in large iron stills. The stills are heated like steam-boilers, and the vapor produced is condensed in condensers made of gas-pipe placed in long wooden boxes filled with cold water. The condensed products are received in troughs, from which they run into large cisterns for storage, being run into different cisterns according to their quality, especially their specific gravity. The first materials which are condensed are the lightest and most combustible. The density of the liquids increases constantly as the distillation proceeds, till we reach the paraffine oils; the combustibility rapidly decreases, and the oil becomes difficult to burn in ordinary lamps.

The first materials that are vaporized are not condensed by cold but escape as gas; then a very volatile oil passes over, which can be condensed by a freezing-mixture but not by cold water. It boils at 65° Fahr., and produces very intense cold by its evaporation. It is called rhigolene, from the intense cold it produces, and is sometimes used by dentists and surgeons to produce insensibility. It is exceedingly dangerous, because it is one of the most volatile and inflammable substances known. A few years ago Stearn's drug-store in Detroit was burned by it. A boy was carrying a tray filled with bottles of this oil down cellar; he probably dropped the tray, for a crash of breaking glass was heard; the inflammable vapor almost instantly reached the furnace, and the cellar was at once filled with flame, so that not a single person escaped from the drug store, and those in other parts of the building had great difficulty in escaping.

Rhigolene is not saved at all at the Cleveland refineries. The first product that is saved is stored under the name of naphtha, and this continues to be stored as naphtha till the density of the liquid reaches 63° Beaumé's coal-oil hydrometer. From this point in the distillation the products are stored in another reservoir, under the name of kerosene, till the gravity reaches 51° Beaumé. At this point a heavy oil containing a large amount of paraffine passes over, and this is usually stored as paraffine oil. The difference in these three products is not *in kind* but *in degree;* as naphtha is worth three or four cents a gallon, and kerosene thirty-five, and paraffine oil ten, and the line separating each from the other perfectly arbitrary, of course the refiner is tempted to run into the safe kerosene as much naphtha as he can. This lowers the test; so, to neutralize its effect, he runs in some paraffine, and thus makes a profit on both of his inferior products. If he can run five gallons of each of these adulterants into a barrel, he can make a clean profit of two dollars on each, and in works where six thousand barrels are turned out each day it is easy to see that the profit is enormous. Paraffine injures the burning qualities of the kerosene; the lamp burns dimly, the wick chars and gums up, and the light will often go out before the oil is half consumed; and when the light is extinguished a stifling smoke escapes. When such oil is cooled to a low temperature the paraffine will separate, and the oil becomes white, thick, and turbid, or even solid like lard. I have a specimen of such oil bought for my own use and sold as "Michigan State oil." By chilling and filtering I extracted four ounces of solid paraffine from one quart of oil. From all parts of the State we hear complaints of oil freezing, and that they have to get the barrels in and thaw them by the stove before they can pump the oil out. *That is not kerosene;* there may be some kerosene in it, but it is essentially paraffine oil. The presence of paraffine has a singular power of lowering the capillarity of oil. I tried the following mode of comparison: I took several glass tubes of the same size and placed candle-wicking inside the tubes. The wicking was thoroughly moistened with oil, and the tubes placed in oils

of different qualities to see how high the top of the tube could be carried above the surface of the oil and the flame continue to burn steadily at the top of the tube. With good Michigan test-oil the flames would burn for hours at the height of 3⅝ inches; with paraffine-laden oil, at ¼ inch; after chilling the oil and filtering out the paraffine the flame would burn at 3½ inches. The element of danger in the paraffine is that it clogs the wick, retards combustion, and heats the collar and tube of the lamp sufficiently to often explode the lamp; *as the formation of vapor will be determined by the hottest part of the lamp—that which comes in contact with the oil.*

When the chimney is removed, by breaking or otherwise, the temperature of the brass collar rises very rapidly. In fourteen minutes it rose to 161° Fahr. in one experiment, and to 155° in ten minutes in another, and explosions at the side of the wick were incessant till the lamp was put out to prevent destruction. The temperature of the body of the oil was only 85°.

Many people imagine that a lamp explodes like a boiler, from the pressure of the oil or the vapor inside the lamp. In rare cases this can happen, but the usual cause is the mixing of air with the vapor through defective lamps, careless trimming, or burning it very low, so that there is a large amount of vapor. It is poor economy *to turn down the lamp* to save oil; in doing it one runs the risk of explosion.

How can People know what is safe Oil?—During two years in which what is known as the Michigan test-oil, according to the law of 1875, was used, the law being sharply enforced, not a life was lost, nor did a serious accident occur from the use of low-grade kerosene in all that great and populous state. The words of the law that was to prevent the use of the easily inflammable naphtha are: "Nor shall any person sell or offer for sale, or knowingly use, any coal or kerosene oil, or any of the products thereof, for illuminating purposes, which, by reason of being adulterated, or for any other reason, will emit a combustible vapor at a temperature less than 140° Fahr."; also, to guard against the paraffine, "to reject for illuminating all oils

which . . . will not remain colorless and transparent when cooled for ten minutes to the temperature of 20° Fahr."

Dr. Kedzie was not a maker of oil nor a seller of oil; he was only "a true knight of learning," bent on knowing and declaring the truth, and not to be daunted nor swerved from a course of experiment and investigation on which he had entered, with a conscientious determination to do his whole duty. He perceived the unscientific construction of the oil-testers in use, and set himself to produce one which would give accurate results and still be so simple in construction that any person of ordinary capacity could use it. He meant to make an article that could be used in the remote mining and lumbering districts by any man who knew enough to fell a tree or wield a pick. It is the remote and inaccessible districts to which the worst oil is sent, as there the difficulty of bringing the offender to justice is great. The distinguishing peculiarity of his tester was a copper vapor-chamber above the containing vessel, which closely represents *the vapor which will form above any kerosene in the lamp.* He took out no patent on his invention—didn't even call it the *Kedzie* tester—but dedicated it to the service of the State Board of Health, and it is known as the Michigan Board of Health Tester. By a slight change in a mechanical detail, made at the suggestion of Mr. A. H. Elliot, of New York, the testing is rendered more simple and certain. It costs but a trifle, and if any one suspects the quality of his oil, a brief experiment will enable him to ascertain the truth (Fig. 9).

Description of the New York State Oil Tester.

Fig. 1 represents the instrument entire. It is properly a closed tester, although not so completely closed as some other instruments. It consists of a sheet-copper stand 9 inches high and 4½ inches in diameter. On one side is an aperture 3½ inches high, for introducing a small spirit-lamp, *A*. The analysts decided to employ a small gas-burner in place of the lamp, as being somewhat more convenient when a supply of gas was at hand. The water-bath, Fig. 2, is also of copper, and is 4½ inches in height and 4 inches inside diameter. The opening in the top is 2⅞ inches in diameter. It is also provided with a ¼-inch flange, which supports the bath in the cylindrical stand. The capacity of the

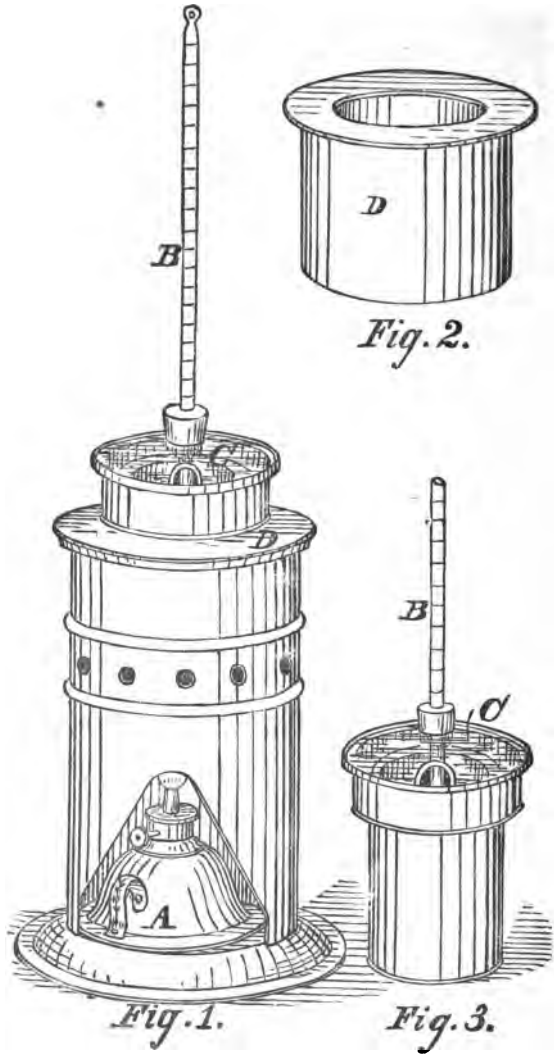


FIG. 9.—New York State oil-tester.

bath is about twenty fluid ounces, this quantity being indicated by a mark on the inside. Fig. 3 represents the copper oil-holder. The lower section is 3⅝ inches high, and 2¾ inches inside diameter. The upper part is 1 inch high and 3⅜ inches diameter, and serves as a vapor-chamber. The upper rim is provided with a small flange which serves to hold the glass cover in place. The oil-holder contains about ten fluid ounces, when filled to within one eighth of an inch of the flange which joins the oil-cup and the vapor-chamber. In order to prevent reflection from the otherwise bright surface of the metal, it is blackened by forming a sulphide of copper, by means of sulphide of ammonium.

The cover, *C*, is of glass, and is 3⅝ inches in diameter, and in one side is a circular opening, closed by a cork, through which the thermometer, *B*, passes. In front of this is a second opening, ¼ of an inch deep and the same in width on the rim, through which the flashing jet is passed in testing. The substitution of a glass for a metal cover more readily enables the operator to note the exact point at which the flash occurs. A small gas-jet, ¼ inch in length, furnishes the best means for igniting the vapor. Where gas can not be had, the flame from a small waxed twine answers very well.

DIRECTIONS ADOPTED BY THE NEW YORK STATE BOARD OF HEALTH FOR MAKING THE TEST, SO THAT THE LAW ENACTED IN 1882 SHALL BE COMPLIED WITH.

The law has established 100° Fahr. as the standard of safety, and prohibits the sale of illuminating oils which shall emit an inflammable vapor below this temperature, and also declares that oils used for the illumination of any passenger-car, boat, or stage, must not ignite below 300° Fahr.

1. The test shall be applied according to the following directions: Remove the oil-cup and fill the water-bath with cold water up to the mark on the inside. Replace the oil-cup, and pour in enough oil to fill it to within one eighth of an inch of the flange joining the cup and the vapor-chamber above. Care must be taken that the oil does not flow over the flange. Remove all air-bubbles with a piece of dry paper. Place the glass cover on the oil-cup, and so adjust the thermometer that its bulb shall be just covered by the oil.

If an alcohol lamp is employed for heating the water-bath, the wick should be carefully trimmed and adjusted to a small flame. A small Bunsen burner may be used in place of the lamp. The rate of heating should be about two degrees per minute, and in no case exceed three degrees.

As a flash-torch, a small gas-jet, ¼ inch in length, should be employed. When gas is not at hand, employ a piece of waxed linen twine. The flame in this case, however, should be small.

When the temperature of the oil has reached 85° Fahr. the testings should commence. To this end insert the torch into the opening in the cover, passing it in at such an angle as to well clear the cover, and to a distance about half way between the oil and the cover. The motion should be steady and uniform, rapid and without any pause. This should be repeated at every two degrees rise of the thermometer, until the temperature has reached 95°, when the lamp should be removed, and the testings should be made for each degree of temperature until 100° is reached. After this the lamp may be replaced if necessary, and the testings continued for each two degrees. The appearance of a slight bluish flame shows that the flashing-point has been reached.

In every case note the temperature of the oil before introducing the torch. The flame of the torch must not come in contact with the oil.

The water-bath should be filled with cold water for each separate test, and the oil from a previous test carefully wiped from the oil-cup.

2. The instrument to be used in testing oils which come under the provisions of Section 2 of the law, shall consist of the cylinder shown in Fig. 1, and the copper oil-cup shown in Fig. 3, together with a copper collar for suspending the cup in the cylinder, and an adjustable support for holding the thermometer.

3. The test for ascertaining the igniting point shall be conducted as follows: Fill the cup with the oil to be tested to within three eighths of an inch of the flange joining the cup and the vapor-chamber above. Care must be taken that the oil does not flow over the flange. Place the cup in the cylinder, and adjust the thermometer so that its bulb shall be just covered by the oil. Place the lamp or gas-burner under the oil-cup. The rate of heating should not exceed ten degrees a minute below 250° Fahr., nor exceed five degrees a minute above this point. The testing-flame described in the directions for ascertaining the flashing-point should be used. It should be applied to the surface of the oil at every five degrees rise in the thermometer till the oil ignites.

4. The thermometers used for these tests should be compared from time to time with a standard thermometer, with special reference to the accuracy of the 100° and 300° marks.

Opposition to the Michigan Law to secure Pure Kerosene from Manufacturers and Dealers.—The Chicago fire, which, rightly or wrongly, was believed by many to have been caused

by the ignition of poor kerosene, and a series of destructive conflagrations elsewhere, and the loss of many lives, had about 1870 roused people in many sections of the country to feel that some vigorous measures ought to be taken to restrain the making and vending and using of a murderous and incendiary quality of kerosene. Legislators were full of zeal, but the zeal was not always according to knowledge; different States established different tests, and the poorer grade of kerosene "passed" under the lax law of one State was "run in" to the one which had the severer standard, either covertly or openly.

In the act which created the Michigan State Board of Health in 1873, there is this phrase: "To have the general supervision of the health and *lives* of the citizens of this State." Naturally, they looked into the sale of explosive kerosene, and as naturally made to themselves enemies of the makers and venders of the same, and, we may add, consumers also, for, unlikely as it may seem, there were people who, to save a few cents, would go over the line into Ohio and buy low-grade oil, in more than one instance paying for their folly with their lives, while among the opposite class of cautious and highly intelligent people were many who doubted if a material that contained such possibilities could in any way be made safe for household purposes.

How Legislatures change Laws through influences brought to bear by Corporations.—It is self-evident that the number of persons, being users, for whose interest it is to have safe oil, is many times greater than the number of those who, being makers, would like to sell without detection or hindrance an oil which is made explosive by adulteration with naphtha or benzine, or by paraffine and those gross matters that make it give a poor light and a horrible odor. And yet, the manufacturing corporations are alert, compact, and rich; they can bring systematic, organized influence to bear, not to name direct bribery; while the great public and even legislatures are apathetic, unless subjected to the perpetual ding-dong of warning and alarm. It seems as if, at times, whole legislatures had been

subjected to sleeping-potions, so easily are vital changes made in important laws, as will be seen when we show how, under the pretense of "changing the phraseology," a wholesome law was changed from a blessing into a comparative curse. In 1867, Ohio—the State in which are the headquarters of the greatest oil monopoly of the world—had a law with stringent safeguards and severe penalties in regard to inspector and manufacturer. But for some reason this law was not satisfactory to *somebody*, for in 1872 it was repealed, and a new law enacted. Under the first, the judge of the Court of Common Pleas was to appoint the inspectors; and these were to have six cents per barrel for inspecting where there were three refineries in a county, and ten if there were less. The Standard Oil Company refined 7,000 barrels per day, $420 was the fee on inspection, and of course they preferred to be rid of paying it. Whoever the parties were that procured the changes in the law, they seem to have been thorough men, and to have made a "clean sweep" while they were about it. The new law provided that the "test" should be as follows: "and if it emit a gas or vapor that will ignite at any temperature below 110° Fahr., then it is to be declared dangerous, etc., and it shall be unlawful to offer it for sale."

Section 2 provides that, "if anybody shall offer for sale any oil, etc., until after *he or they have tested, or caused the same to be tested*," etc. Here was a change indeed! The interested parties *were to inspect their own work*, or have it done by persons of their own selection, with absolutely no penalties for fraudulent branding or false inspection. The practice in Cleveland was, that the manufacturer hired some one to do the work and brand his barrels. He was but a hireling, and the greatest risk he ran was the danger of losing his employer's favor; yet the barrels were branded, "Warranted to stand 150° fire-test." Of course, there was just so much good black paint wasted to disseminate a dangerous untruth. Soon afterward, Dr. Kedzie collected and examined sixty-six specimens of the products of various companies; he gathered them from all parts of the State of Michigan, so that they should truly represent

the lights that people everywhere were depending on as safe "inspected" oil. Some of them stood only the test of 100°, or 109°, and flashed at 90° ; but, to guard against any error in his own method of testing, he got Dr. Garrigues to test fifteen specimens, with a similar result.

Where was Michigan law the while? Thereby "hangs a tale." In 1869 a law had been made to reject all oils that would not stand the flash-test of 110° Fahr. In 1871, while the stringent Ohio law was in force, in an unwitting and unguarded moment, the Legislature of Michigan allowed oils that had been lawfully inspected to be admitted without re-inspection, but it was still on the statute-books that oils must stand 150° *fire-test ;* so, presto ! every Ohio inspector changed his stencil-plate to meet the printed law. There were still left dealers in oil who did not wish to burden their consciences with any kerosene-murders ; but they were "confronted" by a set of "scalpers," who could and would and did undersell them, and thus drove them from the market. Michigan has biennial sessions, and when the Legislature convened, these honorable dealers hoped, through the Board of Health, to have the law reformed in the true interests of the people. The changes were :

1. To have a State inspector.
2. To reject out-of-the-State inspection.
3. To adopt the State Board of Health tester.
4. To permit the use of gasoline when the reservoir was outside the building to be lighted.
5. The "FIRE" test of 150° Fahr. was retained, but the "flash" test was reduced to 140°.

The only "loop-hole" left through which refiners could now reap nefarious profits was to "gum up" wicks by paraffine—and this they did ; and again science and experiment came to the rescue, so that, in 1877, what is called the *chill*-test was incorporated in the law. The good effects of these laws were soon apparent. In the year 1878 but one person lost her life in the entire State ; and investigation showed her to have been using oil bought in Ohio, which was below the Michigan standard. But the refiners did not sleep ; and in 1879 it

was discovered, from various points, that a "pressure" was being brought to bear to have the flash-test reduced to 120°; and in reference to it Mr. M. V. Bentley, of Detroit, a heavy dealer, who had had practical experience in refining oils, wrote:

". . . I know we have the best and safest law in the Union, and it would seem rather foolish to make a change now. Since the present law took effect we have had a good oil to burn; besides, I have been unable to trace a single accident to inspected oil. I also believe that the present test has saved at least a quarter of a million dollars in property since August, 1877, the date when the law took effect" (seventeen months).

This "pressure" took form in printed petitions to the Legislature, *distributed by agents of the refiners*, to have the flash-test reduced 10°, and the *chill* altogether, *which was done!* The security gained by a sound law had made people forget the horrors that had preceded the wise action of the former years. There was no difficulty in tracing the "organization" of the alleged "uprising of the people" for poorer oil to Cleveland, but the "influence" proved too strong to be resisted, and so a step backward was taken; still, the present law is a great advance on that of 1869.

This presents a fair picture of the sort of opposition that boards of health have to contend against. In times of the invasion of an epidemic, the public looks to Boards of Health to check its ravages; then people can see how good and useful they are; but in times of ordinary security they are very well *till they do something*, and then they find organized opposition prepared to thwart them. But let them not be disheartened: they and their works are part of the irrepressible progress of the nineteenth century.

Lamps become old, and need examination, to make sure that they are in good condition. In an account of an accident which occurred through the actual wearing out of a lamp, the innocent owner said, "The lamp had acted well six years, and we thought it always would"!

Dangerous Oils sold under Fanciful Names, and to be "treated" to be rendered "safe."—All over the South and West are sold, large quantities of naphtha and benzine, under such names as Rose-Oil, Liquid Gas, Black Diamond, Safety Gas, Paroline, Sunlight-non-explosive Oil, etc. The nefarious sale of these, which are no more and no less than naphtha and benzine, can not be too strongly condemned; but the most insidious form of the evil is the sale of secret and patented recipes and powders, which glib-tongued agents claim, and gullible persons (wholly ignorant of the deadly nature of the oils) believe, are a complete protection from the danger of explosions. Here are two specimens, taken from the "Patent-Office Report" for 1866:

No. 58,180: Naphtha, 40 gallons; potatoes, 50 pounds; lime, 4 pounds; sal soda, 4 pounds; curcuma, 3 pounds. No. 59,797: Gasolene, 40 gallons; sulphur, 5 pounds; rusty iron, 100 pounds; onions, 1 bushel; rosin, 5 pounds. As these ingredients can have no influence in checking the inflammability of the naphtha, benzine, or gasolene to which they are added, they can have no possible effect but to render these foolish buyers more careless in the handling of it.

There are powders hawked about the country at seventy-five cents the box, containing a reddish substance that it is claimed will render naphtha safe. Analysis has shown them to consist of common salt dyed with aniline red. These are called "Fire-Test Powders," and the directions are, "To one gallon of oil put one teaspoonful of the preparation and shake well." Here is one that we give *literatim*: "Agazziz gas-killer—warranted genuine." With the directions is inclosed the following hand-bill: "No more explosions from kerosene-oil, and saves you one gallon in five, and making it safe as water, and prevents the breaking of chimneys and removes the unpleasant odor from the oil. You that burn the oil should *look to the safety of your family and your homes*, as the cost is but a trifle and makes you safe; sixty cents per box, or two for a dollar. For sale by W. H. Ryan & Co., Albion, Michigan." People do not seem to reflect that if any substance were known that could possibly render naphtha a safe oil, the refiners would

not be slow to use it, to redeem from waste the large quantities that they now utilize in feeding the fires of their stills. As salt will not dissolve in naphtha, it has no influence whatever on the oil, but some of the recipes add ammonia and alcohol and other volatile substances, which still further aggravate the combustible qualities of the liquid.

The recipes are sold at two dollars to a family, and lusty threats of prosecution for infringements accompany them! The inventor adds to his potatoes, and rusty iron, and onions, at least one unfamiliar and chemically-named substance, to strike the imagination of his victims, and there would be something ludicrous in his proceedings if his death-dealing deception were not often followed by the most ghastly consequences. Mr. H. L. Hines, of Eaton County, carried home a can of "non-explosive" oil, which he told his family "wouldn't explode, even if it was thrown into the fire," and proceeded to demonstrate its non-explosive qualities on his kitchen stove, notwithstanding the remonstrances of his family and friends. A terrible explosion was the consequence; the burning oil was thrown upon the clothes of his wife, who was immediately enveloped in flames. Terror-stricken, she rushed out-of-doors and ran to the house of a neighbor. She lived four hours. A child, three years old, was frightfully burned, and soon died. Mr. Hines was badly burned on the face and arms. A lady present at the same time was badly burned, and the house and furniture were speedily reduced to ashes.

The agent who sells these murderous compounds demonstrates that they will not explode, as follows: He pours a small quantity into a saucer, and applies a match, when "it does not explode, it only burns, as you see." The same experiment can be done with *nitroglycerine* and it does not explode —is nitroglycerine therefore non-explosive? Another agent unscrews the lamp-top and plunges a burning match into the lamp, when the oil takes fire without explosion. The vapor itself is not explosive, and only becomes so when mixed with a certain amount of air; equal volumes of vapor and air will not explode; three parts of air to one of vapor give a vigorous

puff when ignited in a vessel; five volumes of air to one of vapor give a loud report; and the maximum of violence is attained by exploding eight or nine parts of air with one of vapor.

It seems incredible, but, even after many accidents from these cheap illuminators, reckless people would go "over the border" into Indiana and Ohio and bring back their death-warrants, where, under a wise law for four years, there was not a life lost from the use of State "inspected" oil.

Oil-Stoves.—As these great comforts and conveniences are nothing more nor less than kerosene-lamps with boiling and baking apparatus attached, every word of caution against the use of poor oil in them applies with equal force to the "oil" stove, but, in the hurry of the preparation of food, these last are much more liable to be carelessly handled than the first. Used with a perfectly non-explosive oil, in summer-time, when one merely wishes to make "a cup of tea" or cook a simple meal in a narrow city "apartment," they are a great boon; but it must not be forgotten that we are dealing with a chained giant, and that in one moment of relaxed vigilance he may turn and rend us.

CHAPTER V.

WHOLESOME WATER.

The Water-Supply.—As contaminated drinking-water probably produces more preventable diseases than any other known cause, the faithful guardian of her household's health, will be interested in a detailed study of its various impurities, and the best methods of avoiding them.

Water constitutes about seven tenths of the entire bodily weight. No structure or tissue is without it, not even the bones and teeth, while in the blood and bile it forms the principal medium in which the substances that are to renew the ceaselessly wasting tissues are dissolved. If deprived of it we soon suffer intensely, as all travelers on arid deserts, and soldiers on forced marches testify. Being a prime necessity, the points where it can be easily obtained determine the site of settlements; but it is only within the last thirty years, since the development of the compound achromatic microscope, and the more advanced methods of chemical analysis have been used, that people have learned that, though clear and sparkling to the taste, it may hold substances that can destroy health by an insidious poisoning that is not suspected till a paralyzed wrist refuses to respond to the will; or, it may so irritate the alimentary apparatus, and pervert its functions, as to undermine the most robust constitutions; or, it may bring deadly disturbances and swift death when it has become the vehicle of those animal excreta, which, once rejected from the system, become to it thenceforward destructive poisons.

Wells.—Everywhere the surface of the earth is underlaid by water which originally fell from the sky. This subterranean water has its rise and fall according as the season is "wet" or

"dry," and its currents and counter-currents depending on a multitude of local circumstances.

To obtain this water for human use wells are made, which are formed by excavating or boring down to this subterranean ocean, and surrounding the cavity by a wall of brick or stone, to prevent the earth from caving in, and then the water is raised by means of buckets or pumps. If the water has become contaminated by substances filtering down from above, there will be no safety—as some people imagine—from a "driven well": it, too, will raise up impure water. Of course, the deeper the well can be carried with an absolutely impervious side-wall, the less danger of its having contracted impurities; and the Michigan State Board of Health recommend, as "the cheapest and most desirable," the wells that are constructed by means of a well-auger which can bore from twenty-five to fifty feet in a day; the well is lined with glazed tile or pipe, cemented at their joints with water-lime cement. When the well has been lined, a filter is made by throwing in coarse sand and washed gravel to the depth of fifteen to twenty inches; the top is securely closed with stone laid in cement. Wells of this class are a great advance upon those loosely built, as they avoid completely the contamination by soil-water, and, if the water come from below a stratum of considerable density, it will remain uninfluenced by the local impurities of the region much longer than if made in the ordinary way.

How different this is from the large, loosely-stoned-up, shallow wells that most people have seen, needs hardly be said. In many of them the water looks clear and pure as one gazes from above into its still depths, and it tastes sweet and sparkling, i. e., aërated. There are many wells whose waters are pure and health-giving, but, taking the whole country through, there are thousands that have become poisoned—unfit to be used—because they have become the vehicles of those human or animal substances which, having been eliminated from the bodies of which they once were parts, are just as certainly poisons as arsenic or strychnine. They are undoubtedly often

so diluted that they do not slay outright, but by a sure, slow, and insidious process, they render the lives of their victims one long martyrdom to some form of *malaise*—which the sufferer expresses as "being miserable." When associated with the germs of certain specific diseases, as will be presently demonstrated, the marksman's rifle or revolver is hardly more deadly.

The way in which wells become polluted will be better understood by imagining, instead of a lining of bricks or stones, one formed of sheet-iron, perforated with holes like a grater. If you pour a barrel of brine on the earth two feet from the well, it will not be long before you will find the brine trickling down on the inside of the perforated iron curbing. It will have "leached" through the intervening earth, for the well drains a cone of earth whose apex is situated at the bottom of the curbing. Lay a large pile of salt on the earth, and leave it exposed to the action of the ordinary rainfall—it will dissolve and find its way to the well. "But," argues an objector, "the sides of the well full of perforated holes are very different from those made of brick or stone." Not at all. The holes in the iron are visible; those in the porous brick are there all the same. A brick covered with porcelain glaze, save for a small space at either end, can have air blown through it from the mouth of an operator so as to make visible bubbles of air rise through water which immerses the opposite end; and stone walls, even when laid in mortar or ordinary cement, have still apertures large enough to admit myriads of those disease-germs that measure but the $\frac{1}{3000}$ of an inch in diameter. If the outside of the curbings of wells could be covered by a perfectly impervious cement, it would have a defense against the entrance of undesirable elements, but not one well in a thousand is so made. The "tube" or driven wells that are such a boon to the solitary farm-houses of the land furnish a security, provided they can be located sufficiently far from farm-yards and out-houses, or driven in a location where it is known that there is a bed of clay near the surface, or a stratum of hard-pan, through which the tube can penetrate.

In the early settlement of the country the bare struggle for existence forced people to do anything and everything "to save steps." Hence the well was dug near the house, and too often a cess-pool and a barn-yard and a pig-sty were located so near it that their contents inevitably found their way into the water of the well.

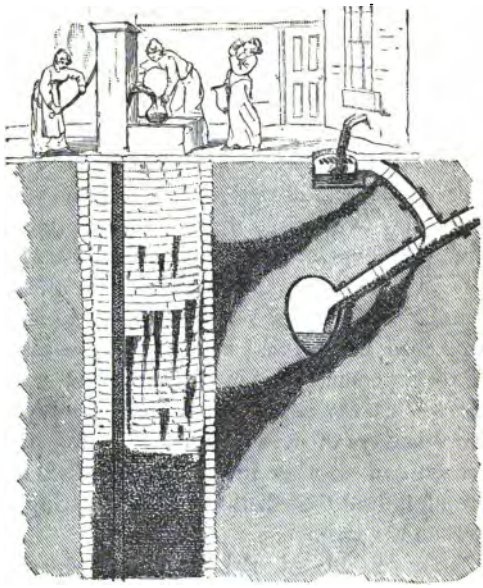


FIG. 10.—How people drink sewage.

There are now on record in the archives of the various State Boards of Health multitudes of carefully investigated cases where well-water has been contaminated by the entrance of kitchen-slops thrown on the ground with no pretense of drainage, and multitudes of others where a "shiftlessly" con-

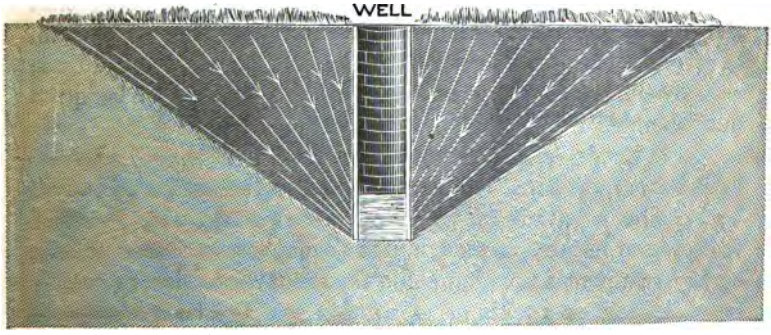


FIG. 11.—Cone of filtration.

structed wooden drain has decayed and collapsed and ceased to attempt to act as a drain. An inverted cone, with its apex supposed to be at the bottom of the well and its base at the surface as broad in diameter as the well is deep, corresponds in a general way with the area from which a well draws moisture, but there are many circumstances that greatly increase the power of the well to "leach" the surrounding soil, so that it is easy to see why disease-germs produced hundreds of feet away find entrance to wells (Figs. 10, 11).

In Fairhaven, Massachusetts, in 1879, every member of one family had typhoid fever. The discharges of the first one attacked, had passed to the privy-vault without disinfection. Every person drinking of the well-water, eight in number (seven at the same time), had the fever within a period of twelve days of each other. A bushel of salt was put into the vault, and another in six days, which soon affected the well one hundred feet distant, demonstrating a communication between the two.

Dr. Budd, of Bristol, England, relates the following: "Some months ago a lady living at the head of a large village in the west of England, being much annoyed by the stench from her house-drains, consulted on the subject a retail chemist, who advised her to drench the drains daily with carbolic acid. Soon after this, the same lady returned to the shop and asked with ineffable *naïveté* if she couldn't be supplied with a disinfectant *devoid of smell*, her reasons being that the operations with carbolic acid had not been carried on many days before the water in her own and some of the neighboring wells stank so badly of the acid as to be quite undrinkable."

In Oxfordshire, England, a barrel of petroleum had been buried in an orchard. In consequence of the escape of the oil by leakage, a circuit of wells lower down and nine hundred feet distant became tainted, and the occupants of fifteen houses, eighty-two persons, were unable for ten days to use the water for drinking or cooking! Had this soakage been sewage, it would not possibly have been detected at all, but it might

easily have been followed by an "unaccountable" or mysterious outbreak of typhoid fever.

In experiments connected with the working of wells five hundred feet deep in England, connected by large adits and pumped by steam for the permanent water-supply of two large towns, it was demonstrated that water found its way back into them from the distances of three hundred and twenty, and four hundred and twenty feet. In France large quantities of artificial nitre are manufactured by piling huge tumuli of animal refuse under sheds, and watering them from time to time with the putrid liquids from the farm-yard. The ground beneath becomes saturated with the salts, and nitrates and nitrites have been found below them to the depth of ninety feet. Nitrates and nitrites are the sure index of animal impurities. In view of these facts, is it any wonder that some populous villages, where the ground is perforated with alternate wells and cess-pools that make no pretense of being water-tight, are full of ailing people, men and women who "never see a well day"?

Professor Kedzie has devised a very graphic way of showing how leaching cess-pools contaminate the ground by what he calls the "cone of pollution" (Fig. 12). Of course, there

Fig. 12.—Cone of pollution.

are many circumstances that increase or diminish the extent of their influence, some soils being more pervious than others, and, if their contents reach a water-bearing vein, they may be borne far from the point of origin.

Since the wide-spread contamination of well-water has attracted the attention of sanitarians, they have learned not to be beguiled by water "sparkling and bright in its liquid light." They bring to bear on it the compound achromatic microscope and the concentrated electric beam, and the most advanced methods of chemical analysis. What do they find? Often an abnormal quantity of common salt, which at once convinces them that the ingredients of human or animal food have found their way to the well. Then they look for the nitrates and nitrites that are formed by the decomposition and recomposition of nitrogenous substances, and as these substances form nearly one fourth of our food, the inference to be drawn from their presence is unmistakable. Above all, they find certain albuminoids whose indisputable origin is animal excreta. People instinctively recoil, and can not believe that they have been unconsciously imbibing such revolting substances; but let them picture the neat farm-house with "everything so convenient," and then imagine the premises suddenly flooded by a walled-in lake three feet and a half deep, which must perforce percolate down through the ground beneath. It needs no extraordinary gift of prophecy to predict that more or less of "filth" will reach the well, and this is just what does happen more gradually through the action of the water that falls from the clouds at intervals through the year.

"What shall we do?" exclaims the anxious mother as she says, "I have so enjoyed having the well so near the house!" We will give the reply which Professor C. F. Chandler, of New York, gave when asked who were the proper persons to go to for water analyses, and how much would be charged for making them. "Any reputable chemist will give a perfectly correct analysis of well-water, and will charge you from ten to twenty dollars, according to the value of his time. But, as a rule, there is but little faith to be placed in analysis of well-water if there is reason to suspect that the water is contaminated. I myself never feel like assuring a man that, because I find his water in a fair condition, he is safe from typhoid; it may be that at the time his water may be good, but the next

week it may be bad. So much depends upon the state of the soil, the level of the cess-pool, the season of the year, and so forth, that it is always rather against my conscience when I tell a man that his well is safe. Many persons have a notion that a chemist can take a substance like water apart like a telescope, putting one constituent in this saucer and another in that one. They think that when a chemist makes an analysis of adulterated wine, for instance, he gets the logwood in one bottle, the alcohol in another, the sugar in another, and so forth. But it is by no means so easy a matter. We do not know what to look for in well-water which, if found, we can point to and say, 'There, this is what caused your typhoid fever.' The germs of disease are invisible. We can simply say that certain peculiarities found in water, supposed to have produced typhoid and other zymotic diseases, are present. For instance, in making a water-analysis we begin by testing it for an excess of common salt; so much salt is used in cooking that, if the cess-pool drains into the well, the water will contain more salt than normal well-water. Next we look for ammonia, which shows the presence of organic matter, and for unconverted or albuminoid ammonia. In water badly polluted by sewage all these substances are found in unusual quantities. But the specific poison which produces typhoid, diphtheria, dysentery, and diarrhœa, can not be identified. You may take it as a rule that, unless your cess-pool is as tight as a bottle, the sewage will find its way to your own or your neighbor's well."

In that phrase, "cess-pools as tight as a bottle," he tersely outlined the only efficient protection. And now sanitary science goes a step further, and to the question, "*At what distance from a well would it be safe to put a leaching cess-pool?*" it answers, *It prohibits the use of leaching cess-pools altogether.*

Temporary Measures of Security against Bad Water.—If any one, on reading this, perceives that he or she must necessarily be drinking daily, contaminated water, boiling it will destroy the power of harm in the deleterious matter, and filtering it through a clean sieve, allowing it to fall some dis-

tance, will partly aërate it and redeem it from "flatness." There are instances on record where all the members of families who habitually used tea and coffee, and never drank un-

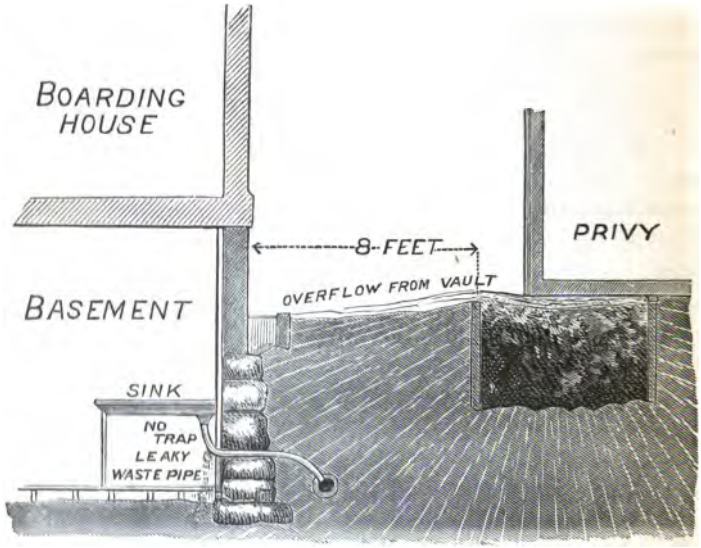


FIG. 18.—The unfortunate boarding-house. ("Sanitary Engineer.")

boiled water, have escaped sickness that affected every individual who partook of the water without boiling, where all parties were supplied from the same well; beer-drinkers sometimes enjoy the same immunity.

"Hard" Waters.—As water is the most universal solvent, there are many regions where the geological formation is such that large quantities of lime, magnesia, soda, etc., are dissolved in the water without attaining the proportions that make them "mineral" waters; but still in many cases enough to exert an unintermitted medicinal effect, which, though not pronounced at first, in the long run produces serious disorders of the liver and digestive apparatus generally. In some cases boiling will partially cure the evil, and it may be nearly removed, if the original impurity is calcium carbonate, by the application of

what is known as Clark's process of softening—a process so simple and efficient that it only needs to be known to be taken advantage of in regions underlaid by limestone. This carbonate of lime has been dissolved by the aid of carbonic acid, which is in the water, and they have produced what is popularly known as a "hard" water; i. e., a water that largely neutralizes the action of soap. The process consists in mixing with the hard water a relatively small amount of water that has had lime slaked in it, and hence contains calcium hydrate in solution. The lime of the hydrate unites with the carbonic acid, and forms a precipitate of calcium carbonate, or chalk—an insoluble powder—which, with the original carbonate, no longer kept dissolved by the carbonic acid, falls to the bottom, leaving a clear soft water above.

This process has been successfully applied to the entire water-supply of some large English towns. It was computed that the introduction of a supply of "soft" water to the city of Glasgow saved enough, in the cost of soap to the united households of the municipality, to pay the entire "water-rates."

In the Western Territories, where the earth is impregnated with alkalies, the only resource seems to be the water which falls from the skies, although great efforts are making to find pure water through artesian wells.

Springs.—It is an almost universal notion that a spring which issues from the earth "of its own accord," and which generally looks crystal clear, must be pure; but, though the water has been filtered by passing down through a stratum of earth, it must be remembered that there are two hundred and fifty times as much carbonic acid in the soil as there are in the air, and that the water becomes aërated with it, and that this aids in dissolving various substances, and consequently springs come to have a great variety of chemical constituents in widely varying amounts. The strata through which water passes determine its purity or impurity, and the same want of sanitary care that would contaminate a well, will just as surely pollute a spring. In the case of the buried barrel of petroleum,

that rendered so many wells offensive, the cattle refused to drink, as they had previously been accustomed to do, at a spring. Typhoid fever has been directly traced to contaminated springs.

Specific Diseases produced by using Waters containing Certain Chemical Substances.—It is known in Italy and France that the waters of certain districts will produce goitre; so, thither resort many of the young men who are liable to the conscription, deliberately intending to contract this disease as a complete bar to their entering a military service, that they feel will bring a sure death. It has been shown that water adulterated with sulphurous acid softens the bones of animals. There is on record an outbreak of boils of a peculiarly aggravated type in persons near a factory, who had partaken of water contaminated with sulphuretted hydrogen. Water which has drained through a marsh is known to produce dysentery and other enteric troubles. In some of the Oriental cities there are local cutaneous diseases that are popularly supposed to come from drinking the waters of the regions, as the "Aleppo rose"—a species of boil—the Damascus ulcer, the Delhi boil, etc., but light has been thrown on their origin by the introduction of English sanitation. With the thorough cleaning out of the wells, especially the "sacred" ones, the diseases have greatly diminished. At these wells, hallowed by centuries of traditions, the pilgrims drank, sure of an accession of holiness. One company suffered from a frightful epidemic of loathsome boils. At the bottom of the well a mass of human bones, slowly putrefying, disclosed the cause. The moral of all which is, secure pure water—from the ground if you can; if not, from the sky.

Cisterns.—Very efficient ones can be made by excavating the earth and plastering the cavity with cement; they are also made of iron, bricks plastered with cement, wood, wood lined with metals of different kinds, and of slate; the last being recommended as best, but relatively expensive. Where brick cisterns are used, they should be plastered inside with the best quality of cement, and should be placed so deep in the ground

that they will be cool in summer and not freeze in winter. They should be arched over, and the only wood permissible is a cover for the man-hole at the top. They should be pumped dry and scrupulously cleaned, at least once a year, for the rain-water as it falls washes out the impurities in the air, and, too long stored, it acquires a most objectionable taste, which is a sure index of its unhealthful qualities. It is better to prevent the entrance of the first storm-water that falls, and only allow that which comes through a cleansed and purified atmosphere to remain for use. There are many foreign substances that will come into it from the roof and gutters that form its water-shed. Any housekeeper knows that if these were swept and scrubbed there would be a large accumulation of "dirt" collected, and if not guarded against this must go into the cistern. Often large colonies of pigeons and sparrows make the roof their resort; if it is shingled, there is a constant loosening of woody fiber called "weather-beat," and dead leaves and tree-seeds not infrequently obstruct leader-pipes when not carried forward to "steep" in the cistern-water itself. To guard against this, Professor Kedzie says: "To remove matters held in mechanical suspension it is a good plan to provide a small filtering cistern filled with clean sand to receive the water as it flows from the rain-water pipes, carrying this water after filtering through the sand directly into the main cistern by a lateral pipe connecting the two cisterns." He also describes an arrangement by which one can be sure that insoluble matters have been excluded as the water is pumped out. It is simple and inexpensive. "A brick box, twelve to eighteen inches internal diameter and twelve inches high, is made with well-burned, hand-pressed brick (machine-made bricks are too hard and impermeable by water), laid up with water-lime; the brick may be laid up edgewise; the box is arched over the top, and through this arch the pump passes inside the box, the pipe being securely fastened in the arch by water-lime. When the pump is worked, the water that reaches the pipe must pass through the brick, by which means all mechanical impurities are prevented from passing to the pump—the water is strained

before it is pumped." Great care should be taken in arranging the overflow-pipe, so that it shall not become a leader for noxious gases, as certainly will be the case where it is conducted to a point where its "wasted" water can wash out a vault. Cases of outbreaks of diphtheria and ulcerated throat have been directly traced to this cause.

Simple Tests for Contaminated Water.—Many people live where a chemical analysis of water can not be obtained, even provided they can afford the very considerable sum that such expert examinations justly command, and for their benefit the following is transcribed, from Professor Kedzie's report made to the Michigan Board of Health:

Color.—Fill a large bottle made of colorless glass with the water; look through the water at some black object; the water should appear perfectly colorless and free from suspected matter; turbidity indicates the presence of soluble organic matter, or solid matter in suspension. It should be "clear as crystal."

Odor.—Empty out half the water, cork the bottle tightly, and place it for a few hours in a warm place; shake up the water, open the bottle, and critically smell. If it has any smell, reject it for domestic use.

Taste.—Water fresh from the well is usually tasteless, even though it may contain a large amount of putrescible organic matter. Warming it often develops a taste, which indicates unsafe matters.

Heisch's Test for Sewage Contamination.—The delicacy of the senses of taste and smell varies greatly in different individuals; one person may fail to detect foulness that would be very apparent to persons in whom these are more acute; but if the cause of a bad smell or taste exists in water, the injurious effects will remain; and some waters of a very dangerous quality will fail to give any indication by smell or taste. For such cases Heisch's test for sewage or putrescible organic matter is very valuable, and is so simple that any one can apply it: "Fill a clean pint-bottle three fourths full with the water to be tested, and dissolve in the water half a teaspoonful of the

purest sugar—loaf or granulated will answer—cork the bottle, and place it in a warm place for two days. If, in twenty-four to forty-eight hours, the water becomes cloudy or milky, it is unfit for domestic use. If it remains perfectly clear, it is probably safe to use."

Brooks, Streams, and Rivers.—There are clear brooks in the sparsely peopled parts of our country which supply good water to a limited number of families, but a running stream will always have some vegetable matter and some animal refuse washed into it by the ordinary rainfall; and as soon as manufactures are established, as they are certain to be with increase of population, they will begin to be polluted by chemicals and animal excreta, and this process goes on till the use of the water for drinking has to be given up. The waste from tanneries will foul a stream in such a manner that cattle will refuse to drink it for miles below, and the seeds of typhoid fever have been directly carried from a house higher up on a stream to those lower down. Where whole towns are to be supplied with water pumped up from rivers, or brought in pipes from some distant lake or pond, the women of the place will form "an influence, not a demonstration"; they will generally have but little to say about its introduction, and it is usually a matter of such gravity and importance as to receive the attention of the ablest and most intelligent minds in the community; and at the present time there is such a fund of accumulated experience, and so much scientific investigation brought to bear on the subject, that there is little danger of mistake, and that the water will not be pure; but, in its adaptation to household use, there is a wide field for feminine vigilance.

Diminished Death-Rate and Pure Water.—One of the most striking results of sanitary effort in England is the diminished death-rate that has shown itself immediately in those towns where pure water conveyed in impervious pipes has been introduced; and the late Dr. Tim. Childs, professor in Bellevue College, New York, testified that the introduction of the pure Ashley water in his native town of Pittsfield, Mass., had nearly caused the disappearance of a severe form of dysenteric trouble.

TABLE FROM LATHAM'S "SANITARY ENGINEERING" FOR THE YEAR 1873. THE "WORKS" REFERRED TO ARE OF THE "WATER-SEWERAGE" KIND.

NAME OF PLACE.	Population in 1861.	Average mortality per 1,000 before construction of works.	Average mortality per 1,000 since the completion of works.	Saving of life, per cent.	Reduction of *typhoid-fever* rate, per cent.	Reduction in rate of *consumption*, per cent.
Banbury	10,238	23·4	20·5	12½	48	41
Cardiff	32,954	33·2	22·6	32	40	17
Croydon	30,229	23·7	18·6	22	63	17
Dover	23,108	22·6	20·9	7	36	20
Ely	7,847	23·9	20·5	14	56	47
Leicester	68,056	26·4	25·2	4½	48	32
Macclesfield	27,475	29·8	23·7	20	48	31
Merthyr-Tydvil	52,778	33·2	26·2	18	60	11
Newport	24,756	31·8	21 6	32	36	32
Rugby	7,818	19·1	18·6	2½	10	43
Salisbury	9,030	27·5	21·9	20	75	49
Warwick	10,570	22·7	21·	7½	52	19

Note that in every place there has been a diminution of the death-rate, but note especially the lessening of deaths by consumption. The Spaniards reckon this the third great enemy of mankind, war and famine being the first and second. It has caused *one seventh* of all the deaths in New York city during the last fifty years.

In 1880 Paris had a death-rate of 24, London of 23, Boston of 21, while St. Louis, thanks to her pure water-supply and her splendid system of sewers, comes very near the ideal number of 10 in the thousand, the rate being actually 11·03; and, while during the first decade after the creation of the St. Louis Board of Health the population had more than doubled (1867–'77), there were actually fewer deaths in the latter than the former year. The following table speaks for itself:

		Death-rate per thousand.
1880	New York	26·47
	St. Louis	11·03
	London	16·9

It is a great gain in a sanitary point of view that so many of the young, enterprising cities of even the far West see how much their ability to attract population depends on being able to vaunt their sanitation; so, wherever feasible, they bring a supply of pure water in pipes from some swift river or crystal lake, and immediately add the well-made system of sewers, that is as indispensable to thorough sanitation as "the other blade" is to the single fragment of a pair of scissors. Denver, Colorado, has sewers built in accordance with the best engineering ideas of the time, and the country about is thickly dotted with derricks, where boring artesian wells to get below the alkaline surface-water is being carried on. The windmill, too, becomes a frequent feature on the prairie. It pumps surface-water, and must be watched accordingly.

Lead-Poisoning from Lead Service-Pipes. — Many experiments have been made to find some substitute for lead to use in the service-pipes of houses, but as yet without success. Lead can be bent into almost any shape without breaking, and thus easily lends itself to all the complicated contours to be found in taking water to sinks, bath-tubs, etc.; in short, it is readily adapted to all the crooks and turns in an old house, and that includes the simpler problem of accommodating itself to a new house, where the aim now is to concentrate and simplify the piping as much as possible. Lead lined with tin has been tried, and also that lined with glass, but it is difficult to make good joints in these; and, in short, taking cheapness, durability, and adaptability all into account, lead seems destined to keep the field, for the present at least. But there are some waters so constituted as to act chemically on lead, dissolving some of its particles and forming with some element in the water, compounds that, taken in very minute doses, but for a long time, produce in many persons a type of constitutional poisoning the symptoms of which are colic, constipation, lead-jaundice, blue line of the gums, and paralysis, often taking a form well known to physicians as "wrist-drop," from a partial paralysis of the extensor muscles of the forearm. Some idiosyncrasies are more susceptible to its influence than others, but there is good reason

for supposing that there are, for one case of pronounced lead-poisoning where the water-supply produces it at all, many sufferers who have obscure symptoms—neuralgia, indigestion, feebleness, and others—that group themselves under "feeling miserably." The Massachusetts Reports for 1871 contain many detailed cases, as this was made a special subject of investigation in that year. A few will be cited as typical cases of the different forms in which it is shown. In Bridgewater a boy eight years old had epileptiform convulsions, gradual decline, partial loss of speech and power of motion. Cause not suspected for some time, but when discovered, and the lead pipe removed from the well, the boy completely recovered.

In several cases the true cause of trouble was not suspected till "wrist-drop" came, and in many of them discontinuing the use of lead pipe was followed by recovery. Often these pipes were short, being used from the pump to the water in the well, but, all the same, where the water had the right constituents the evil effect followed. Curious and apparently trifling circumstances develop a sudden malign condition of things, unsuspected till serious derangements lead to diligent investigation. In Concord, Massachusetts, in 1853, four persons were brought near to death by drinking water conveyed through lead. The water was found to be charged with salts of iron from a meadow in which existed a bed of iron-ore, and, through its action upon the pipes, soluble salts of lead were produced in abundance. Removal of the pipe was followed by recovery. A woman had severe constitutional symptoms from drinking water gathered from a lead-painted roof.

To show how some additional apparently trifling factor may lead to the most serious consequences, the following case is cited—and this is a sort of accident liable to be very common: "In the spring of 1869 the head of a family in Massachusetts, then fifty-seven years of age, who had always previously had good health, found himself losing flesh and strength, tormented continually with an unpleasant constriction and pinching in the abdomen, and with pains in the extremities, not following the course of any of the large nerve-trunks. June 19th he had

an attack of colic so severe as to need the attention of his family physician. These attacks were repeated many times, and were accompanied with obstinate constipation and nausea for many days. The abdomen was uniformly and considerably depressed, and the blue line on the edge of the gums well marked. His wife, aged fifty-seven, hitherto healthy, had similar symptoms. A son-in-law who had lately come to reside in the family was still more severely afflicted, being extremely emaciated and feeble. His general appearance was like that of one suffering from malignant disease, and, without the blue line and the family history to aid me in the diagnosis, I should have expected to find a cancerous development somewhere. The source of the trouble was near at hand. The water which the family used was drawn from a well in the cellar through a one-and-a-half-inch lead pipe, extending from the bottom of the well to the sink in the kitchen, about forty feet, an arrangement that had been in use in the house for twenty-four years. The well was walled up with brick, fed from a spring at the bottom, and the water generally stood about six feet deep. The water percolates through gravel subsoil, and is *soft*. The pipe outside and inside was covered with carbonate of lead, and several places were much eroded. The water on analysis proved to have lead in solution, with an unusual amount of *free carbonic acid*, and, when further search was made for the source of this, it was found in fragments of the wooden cover which had decayed. These had fallen into the well, and probably supplied the excess of carbonic acid necessary to act on leaden pipe. The cases recovered immediately and completely on removing the cause of the trouble, and with proper care."

Cases of severe symptoms are recorded from using water drawn in a white-lead keg made into a well-bucket, and many cases from drinking cider drawn through lead faucets. In New York a family were made ill from eating cracked wheat soaked in the *first water drawn* from the kitchen faucet morning after morning, and a London sweep contracted paralysis from being the *earliest* caller at a beer-shop, and getting the glassful that had been next the lead faucet during the night. It is not amiss

to inquire if the wide diffusion of neuralgia may not come from incautious use of water drawn through lead pipes, and the following may be the means of unveiling some companion-piece of mysterious illness: An old farmer had the regular series of lead symptoms and finally wrist-drop, but, as the water was drawn in an "old oaken bucket," and no lead was used in any cooking-utensils, it took a long time to ferret out the source of mischief. On a close investigation of his habits it was found that he was accustomed to drink vinegar and water sweetened, and, liking it fresh, had been in the habit of going to the barrel and drawing a little into his glass through a lead faucet!

Among these reports are many cases of "partial paralysis," "facial paralysis," "gradual undermining of the health," etc., produced by the repeated small portions of lead that enter the system in the constant use of hair-dyes, one of whose constituents is lead. This may not be considered pertinent to the subject of household sanitation, but if a thorough sanitary reform is to be inaugurated it ought to begin at the *head* of the household.

As a rule, "hard" waters act less to the detriment of water-pipes than "soft" ones. The former contain elements that, uniting with the lead, form a hard, insoluble coating on the pipes, while the soft ones form the soluble salts of lead that are so deleterious. Lead-lined tanks follow the same chemical laws as lead pipes, but it is found that a small lump of mortar accidentally left in them causes rapid corrosion, and a number of foreign substances are suspected of setting up a brisk galvanic action that soon changes the character of the "safest" fixtures. There is no way of deciding *a priori* that this water will form dangerous salts with lead, and that one will not; experience only will prove this. The water of springs and wells is much more likely—from its greater proportion of carbonic acid—to form harmful salts with lead than the pipe-conveyed water of cities derived from a lake; and some persons are far more susceptible to lead-poison than others: Dr. Angus Smith says one fortieth of a grain per gallon will affect some persons, while one tenth of a grain is required for others. Parkes

thinks one twentieth of a grain per gallon is unsafe, and his opinion is shared by many high authorities. Wooden pipe for raising water from wells is safer than lead, and will probably last as long.

The discussion of the use of lead pipes has led to a very general belief in their possibilities of danger, and much of their bad influence is counteracted by people almost everywhere allowing the water to run for a time before drinking it; and even in seasons of scarcity of water this practice should be followed. The water that first escapes can be utilized for bathing and laundry purposes.

Tanks.—In places where an intermittent supply of water necessitates storage-tanks, a new field is opened for the housekeeper's vigilance. Too often, once finished and filled, it is supposed that they will take care of themselves. A London sanitarian tells shocking tales of the dead birds, cats, mice, the old combs, shoes, and blacking-brushes, that he found on his first tour of inspection among the tenements of "comfortably poor" people, in tanks that had not been cleaned for five or six years, and whose covers had been broken up for fire-wood. Constant care is the price of safety.

CHAPTER VI.

SEWERAGE AND PLUMBING.

Sanitary Definitions.—How is a house to be rid of matters that destroy health and life?

In answering this question, several words that are often confounded need to be accurately defined.

What is a *sewer?* A sewer is an underground passage for the conveyance of water, human excreta, and fluid or half-fluid refuse emptied into it by the smaller drains from houses, factories, and streets.

What is *sewerage?* It is a system of sewers or subterranean conduits, and the word refers only to these works or constructions.

What is *sewage?* It is the material which is or may be conveyed in sewers.

What is a *trap?* A trap is a contrivance attached to a waste-pipe, intended to be automatically filled with water, so as to prevent the return of odors, vapors, or any injurious matters.

What is the object of a "*system of plumbing*"? To distribute the water-supply to those points where it is needed for use.

What is a *system of house-drainage?* It is a system of pipes or conduits by which is insured the instant removal from the house of all liquid and semi-liquid waste matter.

Have these objects yet been perfectly attained? "Perfect" is an extreme word. In the best systems there yet may be revealed defects, but there is no doubt that "when found" science and invention will not only "make a note" of them but it will overcome them, so that the careful house-mother, after having faithfully seen to it in all the sanitary light at present available, may calmly rest in the assurance that "*with pipes of*

proper material, properly trapped, properly joined, properly laid, and properly and sufficiently often flushed with air and water, the object of a system of house-drainage seems to be attained, viz., *the instant removal from the house of all liquid and semi-liquid waste matter, and the perfect oxidation and constant dilution of the air contained in the pipes*" (W. P. Gerhard).

Removal of Excreta.—The urgent and instinctive need of absolute removal is felt by every one; but the squeamishness which would regard the deliberate and thorough consideration of this subject by a faithful mother as a needless occupation of her thoughts by a repulsive and disagreeable matter, is certainly a misplaced delicacy. Neglected, it will thrust itself forward upon offended senses, and wreak its baleful power in sickness and death. Not so does the most refined mother feel, when she sees some darling first-born still in death, slain by the neglected poison. From the day when Moses issued the explicit directions contained in Deuteronomy xxiii, 12–15, to this latest hour of the nineteenth century, it has formed one of the urgent problems of civilization. But it has remained for this age of Baconian scientific investigation to demonstrate that the origin of those mediæval "plagues," which swept off twenty-five millions of people, was largely due to preventable unsanitary conditions as a predisposing cause, after the fatal seed had once entered a province.

Water-Carriage System.—A large accumulation of experience both in Europe and America has shown that, wherever practicable, that system by which all household wastes are received in sewers, borne onward to the outlet by the inevitable "flushings" from water-works, and discharged into running streams, where the organic matter can become innocuous through the natural process of oxidation, is best.

Sewers.—The ideal system of sewers would be conduits perfectly smooth inside, large enough, and having a fall from the highest level sufficient to carry off all wastes. In the new cities of the West, and those of the South which are commencing sanitary work *de novo*, where the work can be laid out from the beginning by a competent engineer, the ideal condi-

tions are easy of attainment. Not so in the old and crowded cities of the East, where the work has been done piecemeal, and the later work has had to be accommodated to the earlier. These are far from perfect; and even in Paris, where volumes have been written on the wonderful sewers, the people are so far from satisfied that they are at the present time seeking light and help from America. But as the improvement of the sewers requires municipal action, a woman must take them as she finds them, and must concentrate her efforts on protecting her house and her family from the noxious effluvia generated in them. Her "sphère" begins where the service-pipe for water and the house-drain enter the street-mains, and, as far as sanitary plumbing goes, it ends at the top of the highest ventilating-pipe above the roof.

The water-carriage system is so superior to any other in comfort, that the best class of country houses, through wells, pumps, and tanks, are sure to adopt it; but where no connection with sewers can be had, as in isolated mansions, redoubled vigilance is demanded in the construction of vaults. "Tight as a bottle" is the grand condition of protection of the waters of the region from pollution, and frequent disinfection and emptying must follow as a protection of the air that will otherwise become infected. The inventive genius of the time is up to its demands, and vaults are now made of solid earthenware, that will meet a want at the South, while stone and cement, supplemented by a small amount of engineering talent, can construct a perfectly efficient one anywhere. An apparatus has been invented by which vaults so made can be emptied with no offense to sight or smell, and is in successful use in Charleston, Baltimore, Norfolk, and many other places.

As this apparatus is expensive (six hundred dollars), the purchase and use of it will very likely yet be achieved through the agency of those village sanitary associations that are springing up on every hand, and through an application of the co-operative principle that furnishes a beneficent rendering of "bear ye one another's burdens." Certainly the principle which unites to extinguish infrequent fires can easily be applied to

systematic inspection and cleansing, to counteract the ceaseless action of insidious blood-poisons. Rural communities can be perfectly protected.

Plumbers.—Next to the mother-in-law, the plumber is the best-abused character of the period; he is the perpetual butt of the "funny man" of the daily press, who represents him as gallivanting about Europe, while his impoverished customer wrings his hands in vain lamentations on the hither shore of an ocean he has no money left to cross.

"Most modest of men is the plumber,
No rival has he save the drumber;
Tho' the world e'er maligns,
Yet he never repigns,
And thriveth in winter and sumber.

"Give him but an order to plumb,
And his bill straightway reaches a sumb
That depletes your exchequer,
'Twould equip a three-dequer,
And leaves you most awfully glumb."

This sort of talk has been so long indulged in that people really believe that, when compelled to employ him, they are inevitably to be fleeced and plundered — which, as brought against a large and indispensable class, is an unjust and unfounded libel. There are just as many honest men to the hundred among plumbers as among carpenters, masons, or painters; but there is an important difference in the circumstances surrounding them, for the slighted work of these last does not reveal itself as bad plumbing does. "Be sure your sins will find you out," applies with peculiar force to the plumber; an ill-compacted joint will proclaim itself in a leak that will ruin a frescoed ceiling or a satin-covered suite in quick time, and the knowledge that this incorruptible detective ever lies in wait for him, gives a fillip to his strivings after thoroughness that otherwise we should not look for.

The modern art of plumbing came into existence in America with the introduction of Croton water in New York, forty-

two years ago; but it was somewhat like learning a trade with nobody to teach it. Its problems and combinations had to be solved *ab initio*. For its successful practice it requires an amount of scientific knowledge and a degree of mechanical skill that shut out dolts. The illustration shows one of the ordinary problems that is presented for the plumber's solution, where

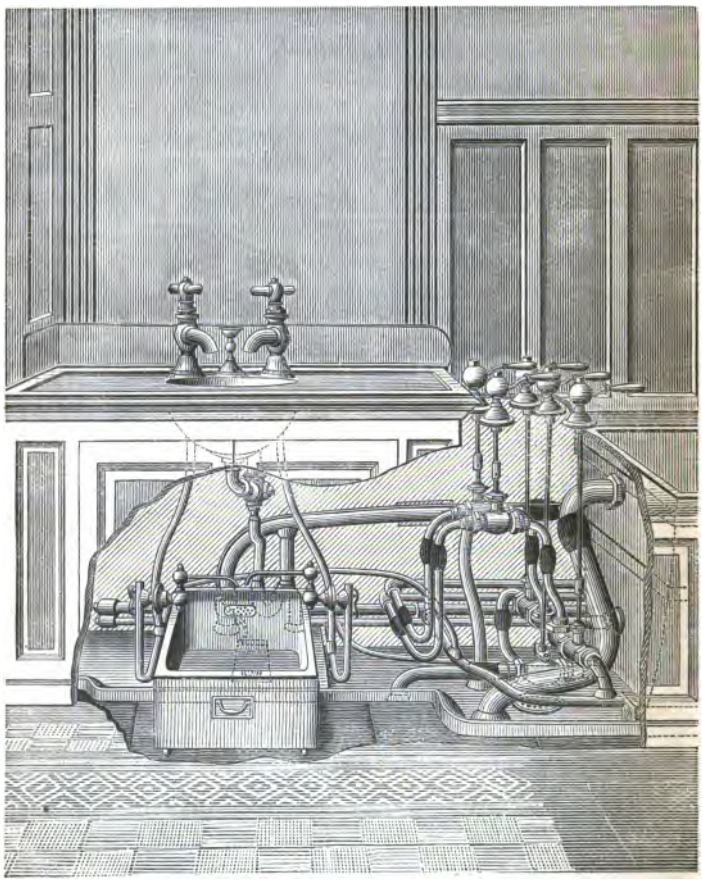


FIG. 14.—Plumbing in a bath-room in the house of Governor S. J. Tilden. ("Sanitary Engineer.")

the hot and cold water supply must be distributed to several fixtures. The man who could solve it successfully is at an infinite remove from a hod-carrier, and it is doubtful if the funny man could achieve it, even though armed with a thousand of his most sarcastic pens. The successful plumber is forced to exercise so much original thought and invention as to inevitably develop the "wits"; so that, when the master-plumbers of the United States came together in convention in the summer of 1883, the expectation that they would form a fine body of men was not disappointed. The plumber has unfortunately been made the scape-goat of the "skin" builder, but even the detestable skin builder has been reformed into a less murderous creature than he was, by the perpetual sanitary ding-dong of the time, and his victim now knows enough to demand traps and ventilating-pipes and cold-air inlets. Ten years ago nobody comprehended the fatal risk he ran in not excluding sewer-air from his house, and Mammon himself, as landlord, didn't know that the price of his wicked economies was blood. In houses "made to sell," all the owner cared for was to have the pipes maintain a decent continuity till after the deed was signed. In a new sense, he thought, "After me the *deluge*," while his directions to the plumber were, "Keep down the cost." In this case the plumber's business was "to obey orders," which he did, plainly foreseeing that in a very short time "the plumber that did that work" would be sum-

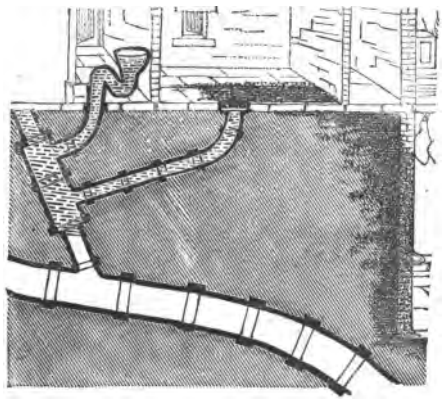


FIG. 15.—A length of six-inch pipe interpolated between two lengths of four-inch pipe, and its consequences.

moned by the purchaser to make repairs. He knew the nature of the cheap shams he was producing, but who was responsible? Public attention has been so thoroughly roused that laws have been passed in several States, and they are more or less perfectly enforced, to protect the helpless occupants of tenement blocks, so that these are more sanitarily housed than those who live even in the better class of private houses, especially if the houses were built before the sanitary awakening; and, above all, if the house was built by a speculative builder.

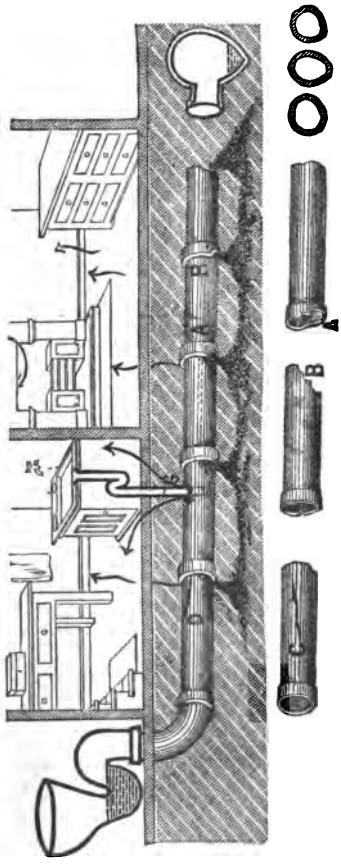


FIG. 16.—Drain made of "seconds," which a witty Yorkshireman said "the jerry builder uses because he can not get 'thirds.'"

The National Association announce, among the purposes of their organization, "the protection of the trade against injustice; to advance the science and art of our trade by eliciting and communicating the experience and ability of all; to regulate the system of employment so as to prevent, as far as possible, the evils growing from deficient training in responsible duties," etc., etc. It would have demonstrated that an uncommon type of saints had taken to plumbing, if, in such a convention, the continual abuse lavished on the craft had not been resented. If "even the worm will turn," much more will

the wide-awake plumber of to-day invite the reporter to keep out and stay out of his convention, even though conscious that the reporter will straightway concoct an article depicting the plumber, with his shirt-front incrusted with diamonds, and bearing a gold-headed cane; and saying that they hired a hall that had the largest safe in the city, for storage of their valuables during their deliberations.

Major W. E. Foster, of Virginia, made an able address, in which he sketched the alert scientific plumber of the future; and, calm in his knowledge that the plumber is a primè necessity of life, and that the "funny man" is only appreciated in those "hours of ease" when no leaking pipe is flooding the parlor, and no deadly stench is killing the household, advised his fellow-craftsmen to ignore him and all his doings. He said: "When an applicant comes to me for employment as an apprentice, I examine him to see if he is well grounded in natural philosophy, if he is up in the rudiments and some of the branches of the higher mathematics. I examine him to know if he can give the contents of a tank, the flow of water, and to find if he understands hydraulics and hydrostatics. I instruct him, that, more with us than with any other trade, rests the life and health of the people, and that by studying the science that underlies the work, the plumbing trade will be lifted to a plane beyond the reach of the 'funny man.'"

The maligned and ridiculed plumber perceives that his calling is fast rising to become a branch of engineering science, and in all parts of the country they are moving to secure a higher training for their responsible work; they are forming associations, in which the noble admiration of good work, that characterized the ancient guilds, seems to be reviving, and a standing joke of their social gatherings is to appoint a "committee on diamond pins"!

The Sanitary Engineer.—He is just as much a feature of the general progress of the day as the railway-conductor or the telegraph operator. The plumber views him with a jealous eye, and hurls hard words at him. But he is come, and come to stay. Not every one who graduates with the title is

a competent "sanitary engineer," and there have been cases where an inexperienced fledgling of this sort, has been called in to examine old work executed by a practical plumber, who was a thinker as well, and who did "know more in one minute than that upstart in a whole day." Especially is the plumber the master in ten thousand questions of "*How to do it*," that arise in dealing with such shifting materials as earth and water, and so he sits in the seat of the scornful, and indites such sentences as this, in his formal address to the convention: "A newly invented profession is sprung upon the world, called sanitary engineering, which proposes to its confiding patrons to guard and protect them against their insidious enemy, the plumber. Boards of health lend their aid to these magniloquent braggarts, by publicly setting the seal of their disapproval on practical skill and experience, and their unqualified indorsement of book-taught experts and newspaper scientists. It is a fact to-day that the men whose lives are spent in the solution of, and whose pursuits lie closer to, the sanitary problems of the day than any other, are ostentatiously ignored, and the claims of raw graduates from medical or other schools are brazenly thrust in the face of the public!" Calm yourselves, gentlemen; as Uncle Toby said to the fly, "The world is wide enough for you both," and, what is more, the world will have you both, and as the editor of "The Sanitary Engineer" said, "it is to be regretted that the convention did not recognize the service which the genuine scientific sanitary engineer has rendered, and is rendering, to plumbers, and direct its strictures against pretenders." Mr. Tyndall says: "The union of scientific minds ought to be organic; they are parts of the same body." But for the glorious work achieved by them in Europe and America, the plumber would be plodding along in the old rut; there would be no Permanent Exhibition of Sanitary Appliances in Berlin, or at the Parkes Museum in London. No, it is ever and always the "book" men who discover the new fulcrums on which the lever that lifts the world to a new level, rests.

Systematic House Inspection.—At no distant day associations will be formed to procure this, and here the expert

sanitary engineer will find a legitimate field; and if we follow the hints in the extracts below, from the constitution of the Northern Sanitary Association of Scotland and England, all friction with authorities and tradesmen can be avoided:

"The Association will in no way conflict with the public authorities, but will supplement their action.

"The officials will be required to have no interest in any trade or commercial establishment, or patent connected with sanitary appliances.

"The functions of this Association shall be to advise, to inspect, and to superintend, but not to undertake the execution of work."

Bad Plumbing in Fine Houses.—The noses of a household had for a long time told them there was something wrong in their house, which was an elegant mansion on one of the most fashionable avenues in New York. They sent for a man who advertises a patent deodorizer and germ-killer, which all competent chemists denounce as worse than useless, as it lulls people into a false security. Having "killed" one "smell" with another and different one, they go on, the house becoming daily more saturated and infected with disease-germs. The particular house we speak of "grew no better very fast"; severe sickness invaded it. Then they sent for a sanitary engineer of high reputation, and the entries he made of the condition of things in his note-book are a more telling comment on the poor plumbing which went into costly houses fifteen years ago than pages of invective. And as it is a correct picture of thousands of houses to-day occupied, and especially where the house has passed from private occupancy and become a rented boarding-house, we insert it entire:

"The drain and soil pipes were mostly hidden from view; the main drain being laid under the cellar-floor, covered with concrete, while the soil and waste pipes from water-closets, bath-tubs, and basins are buried in walls or partitions. Traps for bath-tubs being placed below the floors, could not be inspected without tearing up the floors.

"The inspector was not able to decide whether or not the

main house-drain was cut off from the sewer by a trap, but no fresh-air inlet could be found. The drain itself is vitrified pipe, laid, as stated, under the cellar-floor. At the joints where the soil-pipe and the refrigerator waste enter it (at which point the floor was broken to permit inspection), the drain was found to be badly cracked at the junction of the soil-pipe, and the sewage matters had escaped and polluted the cellar soil. At this point the earthenware hub was broken, and the *two pipes had entirely separated*, leaving a wide opening, while the escaping water-closet wastes gave forth a nasty odor, which poured into the cellar and escaped into the rooms above. A gully in the front part of the cellar, intended to receive the drainage from the cellar-floor, was in a filthy condition, and gave out offensive odors.

"The drain received a number of branches, besides the soil-pipe from sinks, wash-basins, laundry-trays, etc., and from the refrigerator, which made *direct connection with the drain*, and, in the event of the seal of the trap evaporating, an open connection would be established from the sewer to the contents of the refrigerator. No one of the branches above referred to was ventilated by being extended above the roof, but each stopped at the trap of its fixture, thus forming a series of dead ends. In addition, no trap was ventilated against siphonage. The soil-pipe, instead of being carried through the roof full size, was ventilated only by a one and a half or two-inch ventilating-pipe.

"The servants' water-closet in the cellar, an iron hopper, was in a filthy condition. On the upper floors pan-closets were used, and all were provided with a patent disinfecting and deodorizing apparatus, which, it appears from the report, had been employed to conceal the odors arising from the closets. The wooden laundry-tubs gave out a most offensive smell. The tank from which the general water-supply was drawn was placed in a water-closet, over a slop-sink, liable to pollution."

Another house, not half a mile from this, two years ago underwent a thorough replumbing, from street-sewer up. As far as present knowledge goes, it is in perfect sanitary order;

but it was not reformed till it had been the theatre of the following "ow're-true tale." It was the direct cause of four deaths and an uncountable and unweighable total of *malaise* —lack of health:

"Its past can not be recalled. It has now been remodeled, and all that the most enlightened skill of the most competent mechanics can do, quickened by instructions 'to make it right, regardless of expense,' has been done to render it fit for human habitation.

"It was erected fifteen years ago by a speculative builder, whose keen prescience perceived the eligibility of the site, and whose sagacious mind formed a perfectly correct estimate of the future demand for houses in this locality. It was built on 'made land,' and the carpenter, who described the difficulty of laying a foundation, said: 'It was lucky we built six of them; we never could have made a single one stand alone!' Nevertheless, there was a foundation created, stable enough to hold it upright, and in due time it was advertised as 'supplied with gorgeous mirrors and magnificent chandeliers; as stuccoed and frescoed, and replete with every modern convenience.'

"A gentleman, who had hitherto lived in a fine old inherited house in Washington Square—which he never ceased to deplore could not be modernized without spoiling it—found that business was elbowing in where aristocratic quiet had reigned, and the advent of the horse-car added the last unbearable straw. With many a pang he tore the roots of his life out from the dear old home, whence he had seen his venerable parents pass to the silent land, and where his own early happy married life had been spent, and, greatly to the joy of wife and daughters, established himself in the 'frescoed replete.' This was in the autumn. Remember, this was a new house, in a new section; it had not had time to become saturated with disease-germs, and, like the proverbial new broom, it was charming; in fact, all parties were so fascinated by it, that at the opening of the following summer it was decided, in unanimous family council, that the usual three months in the country should be dispensed with, and instead, short excursions should be made to points

of interest within easy striking distance of the city. This programme was followed, and all went well till late in the second winter, when the two daughters were attacked with diphtheria, and, though both recovered, it proved the starting-point of rapid consumption in one of them, and was the occasion of loss of hearing and the beginning of a lingering condition of lassitude and weakness in the other—a condition dimly comprehended then, but in the light of recent discovery easily explained.

"The vitality of the mother was so lowered—by grief and watching, as was supposed—that Florida was ordered for the whole household; and now began a series of laborious packings-up and pilgrimages, to the South in winter, to all sorts of sanitaria and health-resorts in summer, till practically the 'frescoed replete' came to be inhabited but about four months in the year. At length the life of its once bright mistress yielded to a dysenteric attack, and the feeble daughter didn't feel equal to going to Florida; so the sons, who during the various flittings and journeyings had been away, one at college and one at a salubrious country boarding-school, were to remain at home, for the father's heavy heart needed their young faces, with the light of life's morning upon them, to keep him in cheer. Fatal decision! In less than eight months typhoid fever had taken one and typhoid pneumonia the other, and the bereaved master of the house was only too glad, under the advice of his physician, to leave the scene of so much sorrow. Meantime these repeated strokes, which once he would have unquestioningly bowed to as 'acts of God,' assumed a new aspect in his mind. He read of diphtheria, and dysentery, and typhoid as preventible diseases, and the story of Uzzah in the Old Testament, who put forth his hand to steady the ark of the Lord, but who was struck dead, nevertheless, because he had broken an explicit command of God, took on, to him, a new meaning. He came to understand that he had broken laws, unwritten indeed, but just as inexorable, to which the penalty has been annexed by an unerring hand.

"Investigation of the 'frescoed replete,' which had now

been occupied at intervals during a period of thirteen years, showed the drain leading to the street sewer to have 'settled,' so that the end of the last length of pipe—though the pipe maintained its continuity toward the house—'brought up' against a solid wall of earth, its fellow having sunk down out of connection. It had ceased to be a conduit. When the sewage from the public street sewer reached the opening, of course it poured out into the adjacent earth. Of course, the speculative builder had placed no trap outside the house-wall —ventilating-pipes to the tops of houses, and air-inlets to counteract siphoning, had not been heard of by anybody at that time—he had deliberately allowed a cracked length of pipe to be placed just within the cellar-wall; he well knew that it could not sustain the weight of street traffic; but he was not going to waste a length of pipe, not he. So it hid itself under the cement of the cellar-bottom, to be eventually demolished by the same 'settling' impulse that had opened ugly cracks all along what should have been the close junction of the side-wall and cellar-bottom, and which had thrown the whole block 'out of true.'

"The house was warmed by a furnace. When making the cold-air box, the carpenter found his material a little 'short,' so the box left off on the cellar-bottom instead of continuing through the underpinning to the outer air. The getting of enough material to complete it would have involved a fresh order, delay, and fresh cartage charges; so he deliberately decided to use up what he had, and, as he said to himself, 'let the thing take its chances.' If the contractor should criticise and demur, he would feign inadvertence, and finish it up. As things turned out, 'murder in the second degree' would have been none too severe a name for his crime. Here was a conductor which could hardly have been better planned, of set purpose, for the diffusion of disease-germs in every room where there was a register. The contractor, too, 'let it take its chances,' and the new owner made no protest. In fact, he had never examined the setting of a furnace or the construction of its appendages in his whole life.

"The 'system' of plumbing was utterly faulty. There was no ventilating-pipe, nor a 'trap' under a wash-bowl or bath-tub. When the plumber mildly suggested that these last ought to be put in, the builder replied: 'Just costly gim-cracks. I want to keep the cost down, and not have to make such a price on it that buyers will kick. I'm in a tight place unless I can make a quick sale of this first house. Put in stylish decorated bowls and handsome plated faucets.' The only extenuation for him is, that he did not know the fatal nature of his cheapening omissions; and it is no wonder that the plumber improved upon the example, and when a joint would barely adhere with half an ounce of solder, he did not waste another half-ounce in making all secure.

"In distributing the blame, our first thought is that the buyer was culpably careless. He thinks so now. His was a sin of preoccupied ignorance. In judging his action we must not forget that *then* was a very different time from *now;* that fifteen years of persistent labor of voice and pen, by a large body of sanitarians and physicists, both in England and America, has resulted in a general enlightenment on both sides of the Atlantic, which result has been greatly aided by the 'turning on of the gas' by the newspaper press; but in spite of all that, too many at this hour are unwittingly following in his footsteps.

"When his own father built the house in which he was born, he devoted the full energies of an alert mind to the investigation of every point which could help make it a safe and pleasant home for his family. He had his well and pump, his cistern and heaters and ventilating shafts, all constructed according to the latest scientific lights, and after ample discussions with scientific men and mechanical experts. That was in the day when men superintended lovingly the erection of their own houses; 'ready-made' clothes and ready-made houses had not come in then. But the building of the house, which for the time being took engrossing possession of his faculties, had become part of a long-forgotten past when the son's life began, and the son took the house, with all its pleasant ap-

pointments, as a matter of course—somewhat as if it had grown, like the ailantus-tree in the back yard. When he found himself obliged to seek a new shelter, his mind was preoccupied by the cares of a large business. He was an upright man in his own dealings; he measured others by himself, and had no just notion of the lack of integrity in the smooth-tongued, wide-awake, and unscrupulous man into whose hands he fell, whose whole desiccated but unwritten creed would be justly expressed in the rule, 'Never use a first-class brick where a second-rate one will do.' A man of this style, on being remonstrated with lately, replied: 'Folks are getting their heads full of all kinds of senseless crinkum-crankums about houses. If they want things made to last till the judgment-day, they must superintend them themselves, and pay accordingly. They want their houses dirt-cheap, after all.' There is no doubt that people have been too willing to economize in the essentials of health, and have spent too much, relatively, on the ornamentation. The elaborate decorations in the parlors of one 'frescoed replete' would pay for a large amount of the best plumbing; and when a choice must be made, nobody who really appreciates the fatal fruits of sanitary imperfections will hesitate; even the avaricious builder himself does not realize that his ill-gotten money is the price of blood.

"In weighing the responsibility of the sub-contracting plumber of the 'frescoed replete,' we do not forget that he made his contract to do the work called for in a plan which he had not designed; but after he had contracted, when he knowingly inserted the cracked pipe, and did everything in the flimsiest manner, he was not loving his neighbor as himself, and, had he understood the fatal nature of the emanations that diffuse themselves through untrapped pipes, he too could not be acquitted of blood-guiltiness."

Good Plumbing is never cheap.—There are points in house-building that offer opportunity to choose bests and "seconds," with no harm to health, but quality is of prime importance in the material of good plumbing; but as there is no department

where women are so poorly informed as to prices, the space given to the following account of an actual experience will not be wasted :

"A Sanitary Carpet."—A lady who had clear convictions as to the absolute need of good plumbing, a refined taste, and a fixed sum of money to invest, had bought a small city house, and wanted to fit it up comfortably and prettily for her own residence. She had selected the furniture for all parts of the house except her parlors, and it had been chosen with an economy that could not be carried further with comfort. Her pet fancy for her parlors was to have a handsome hard-wood floor, with inlaid border, and she wanted real Persian rugs to cover it. She had had the floor measured and estimated, and she had seen the rugs she wanted—beautiful "symphonies in color." The floor would cost $200, the rugs $650, and the window-draperies to harmonize with all, $150 ; total, $1,000.

There were to be in the house a kitchen-sink with its boiler, a set of three stationary wash-tubs, a servants' closet in the basement, and on the floors above a nicely fitted butler's pantry ; two bath-rooms with closets and lavatories complete, and a housemaid's slop-sink. Of course, the drainage for the storm-water was to be provided for. In order to inform herself as to the probable cost of the plumbing, of which her notions were of the vaguest, she held a conversation with the previous owner, who twelve years before had fitted up his house to live in, and, being a physician, had done it according to all the sanitary lights then to be had. He had spent nothing on mere ornamentation, and it had cost him $300. She made a mental allowance for the advanced ideas of plumbing that she knew had supplanted the old ones, so she said to herself : "It will cost me $400 at the very least ; that, with $1,000 for the parlors, will be $1,400. As I have but $1,300 for both, I must economize somewhere," and she at once changed her plans for her window-draperies. Then she betook herself to a plumber whom she had already selected for his honesty and well-known faithful work. He made a careful inspection, showing her that the boiler alone of all the former plumbing was worthy to be

retained, and then she sat down to a careful computation and close study of items. She instantly found that times had changed in one respect, and that skilled labor commanded four dollars per day, in place of the two dollars that had been called large wages in the former days; so there was another reduction to be made. The plumber explained to her that a rain-water leader, made so as not to burst with ice, was a costly patent article, but would be a saving in the end; and she saw for herself that *ventilating every fixture* with a pipe of undiminished size to the roof, would nearly double the amount of piping; so she made another mental subtraction from her parlor fund. She dismissed the rugs wholly, and thought she would use a softly shaded Axminster; but, alas! when the plumber added up the sum total of iron drain-pipes, enameled to resist the chemical action of sewage, the cold-air inlet to prevent "siphonage," which means sucking all the water out, thus making a clear course for disease-germs direct from the sewer, when all the rings, and chains, and ferrules, and plugs, were counted up, she found that she couldn't even allow herself the Axminster, nor even body Brussels. The entire cost of the plumbing would be at least $850! In a new house where all the fixtures are placed above each other, much is gained by shorter reaches of piping, but in an old house the new work must accommodate itself to old plans, which somewhat enhances the cost. So the carpet finally came down to a simple Dutch ingrain, with a bright border, and a small rug here and there to give it a dash of color. She had been so strenuous to have the plumbing estimated carefully, so that "she might know the worst at the outset," that when completed it fell a few dollars below the figures, but not enough, as the lady said, to "buy an æsthetic bellows," and she finally gave for her carpet and rugs $350, for her curtains $100, and the $850 for her sanitary plumbing; so, though she in no way regrets the changes made in her original programme, she insists on calling her Dutch floor-covering "My sanitary carpet." Happening to run across Mrs. Isabella Beecher Hooker's earnest exhortation to women to "watch the plumbing-work from the

sewer up," she resolved to do her whole sanitary duty, though she didn't feel especially competent to criticise; and the result was a revelation. She did not "overlook" the actual formation of every "wiped" joint, but she penetrated the inner secret of the plumber's big bill. She saw how the accurate fitting of pipes preliminary to soldering often required bending, and cutting, and measuring, and clipping, at least a dozen times; how the worker is often hindered by the carpenter-work not being in a proper state of forwardness at a given time. She counted up the number of joints in sight in a bath-room where there were four fixtures: there were forty-seven above the floor, and nearly as many more beneath it, that completed the connections with the waste-pipes. To each fixture there was a supply-pipe, a waste-pipe, a ventilating-pipe, and a safe-waste, so that to make one union on each required sixteen, and of course all the traps and crooks and turnings multiplied these.

As a preliminary step, one of the much-denounced class of sanitary engineers had drawn up a set of careful specifications for the work, and, at times, as it was progressing, he came and thoroughly inspected it, so that he actually saw every joint; and when it was done he issued his certificate that all the work had been faithfully performed "according to the specifications." A diagram of the completed piping, to which were attached plain directions as to which faucet to turn in case this or that pipe should burst, and which not to touch under any circumstances, etc., etc., placed back to back with the certificate, in a double-glassed substantial frame, and hung in an instantly accessible place, completed this ideal sanitary plumbing. Irreproachable sanitary work is now recognized as an element to be taken into account in the sale of a house. As many as possible of the pipes had been left in plain sight; but, where this was not possible, the concealing wood-work was only fastened with screws.

The three prime canons of house-drainage, stated by Mr. Rogers Field, are:

1. All refuse matter must be completely and rapidly removed.

2. No passage of air can be allowed to take place from drains or waste-pipes into houses.

3. No communication can be permitted to occur between the drains and the water-supply; and, he added, "the soundness of the pipes and joints can only be guaranteed when, the outlet being closed, the drain holds water without any leakage."

A Properly Plumbed House.—Woman's sphere has had a great many definitions. One of its most important ones is embodied in the plate on the next page, which is a sketch of the manner in which the plumbing of a house should be done to secure *perfect sanitation.* It was made by Mr. William Paul Gerhard, a civil and sanitary engineer of the highest grade, who has published a most valuable and useful manual on "House-Drainage and Sanitary Plumbing," in which the details to be attended to, in connection with every process and fixture concerned in sound plumbing, are treated *in extenso.* The aim of well-planned and well-executed plumbing is to insure the exclusion from our houses of those forms of disease that are now believed to be generated and diffused through failure to secure this. In his words, "*by completely removing as speedily as possible all waste matters from the dwelling by pipes thoroughly and tightly jointed, and by a sufficient dilution of the air in these pipes with oxygen, the danger of infection arising from defective drainage and plumbing may be reduced to a minimum.*"

The diagram (Fig. 17) is in accordance with the ripest experience to date, as to the principles that should govern household plumbing, and is also in strict conformity to the rules that have been formulated by various municipal boards of health that are now being enforced in many of our principal cities.

The first step is to concentrate the plumbing as much as possible; i. e., to make fixtures on different floors come under each other as far as may be, thus diminishing the amount of piping, and consequently the expense. The multiplication of fixtures is ceasing to be regarded as a luxury in the light of the possible dangers to health connected with them; it is seen that

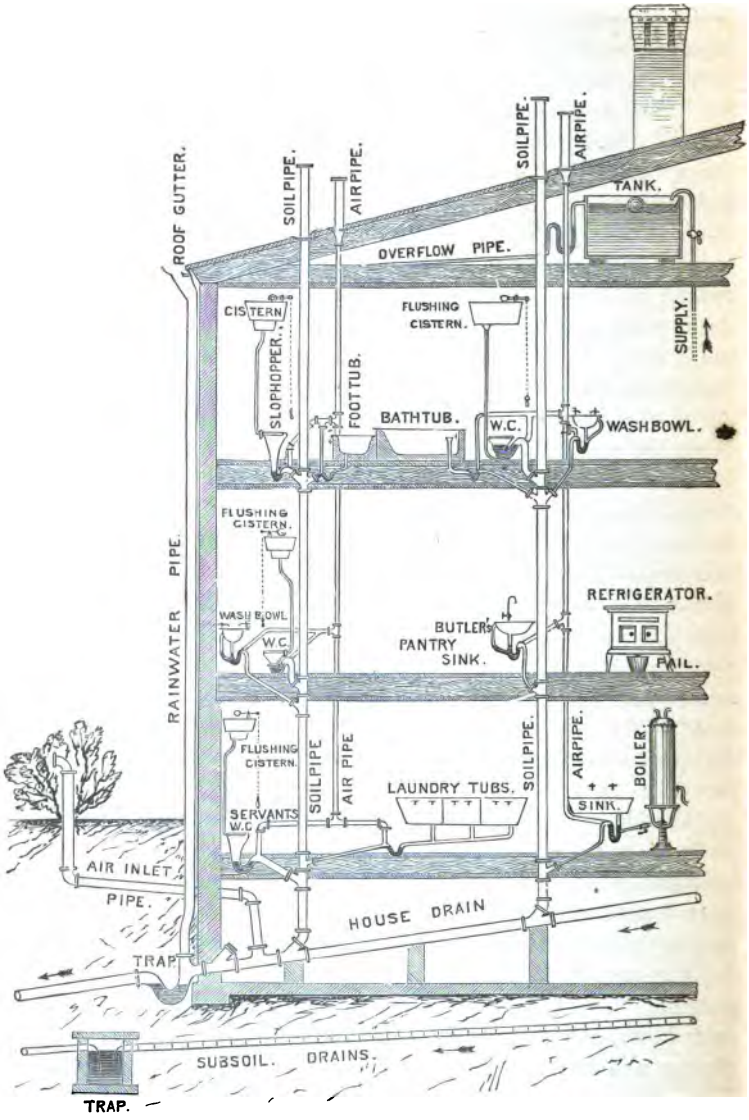


FIG. 17.—A properly plumbed house—Woman's sphere.

fewer fixtures, more frequently used, and consequently more thoroughly flushed, is the best plan. In the most expensive houses, where a first-class architect is employed, the plumbing is all drawn in detail as much as the doors or windows; but, no matter how small or cheap the dwelling is to be, this is a department that needs to be carefully thought out beforehand; only thus can the best results as to health and economy be attained.

Mr. Gerhard begins at the ground on which the house is to rest. "Subsoil-drain" has a rather formidable sound to a lady unaccustomed to such things, but there is nothing about it that she can not comprehend; she need not dig nor lay the drain herself, but she can, if about to build, secure this cheap and efficient protection from dampness. Catarrhs, rheumatisms, and neuralgias are the penalty for neglecting it. This is nothing but a line of ordinary drain-tiles laid with open joints, about which tarred paper or cotton rags are wrapped to prevent the earth from falling in; it discharges into a deep mason's trap, if in the city, and is carried to some proper outlet at a greater distance if in the country. Draining the ground itself is of course beginning at the beginning, and there are probably few points in sanitation where so great benefit may be expected from so little outlay. A lady does not feel called upon to superintend tan-vats; but that does not prevent her from insisting on having good sound leather instead of pasteboard for the soles of her boots.

The next feature is the "house-drain," which forms the common receptacle for all wastes of the kitchen, the laundry, the butler's pantry, the wash-bowls, the baths, and the closets. It should be placed in plain sight throughout its entire length, and it is found in practice better to support it by brick piers than to suspend it from walls above. The most trifling "settle" may, in the latter case, make an opening through which sewer-air can escape. This has a running-trap just outside the wall, and a Y-branch with movable cover just within the wall, so that, if obstruction comes from either carelessness or accident, it can be easily examined. Where it passes through the wall,

a "relieving arch" is formed to protect it from pressure, and into it the rain-water leader with its cleansing flood discharges; also into it is inserted the "air inlet-pipe." It is comparatively lately that the value of this indispensable adjunct of sanitary plumbing has been appreciated. It is just as necessary as a constant supply of water; by it fresh air is always "flushing" the pipes, thereby oxidizing and disinfecting the inside of the pipes themselves. The objector argues, "What need of that, when the pipes are daily and hourly washed with water?" Let a lady reflect on the common process of washing dishes: to be thorough, and remove grease, this requires that dishes shall be *rubbed*. Are the insides of pipes rubbed? By no means; so that if a wash-bowl with the ordinary waste-pipe, cleansed in the usual way by flushing from the faucet, for, say six months, were examined, the pipe would be found coated with a slimy substance formed principally of grease (this from soap), but containing a multitude of particles of other matters that have passed from time to time into it. That from the kitchen sink and the butler's pantry would be worse, while the climax is reached in those coming from the slop-hopper and the closets. It will be seen that the "soil-pipes" are carried up with *undiminished size* as far as practicable above the roof; care should be taken that these pipes do not terminate near windows, sky-lights, ventilating-flues, nor too near chimneys, whereby poisonous gases may be conducted into houses or apartments. In this illustration it will be seen that the rain-water leader for one wing of the house, which connects with the sewer, must be a source of danger to people in the upper story, while the extension of the vent-pipe which dis-

FIG. 18.—Rain leader discharging into window, and *B*, extension of vent-pipe too near attic window.

charges near the attic window must form an equal menace to the sleepers on the "sky-floor." This vent-pipe is all wrong, for now all authorities agree that the caliber of vent-pipes should be increased at the upper end.

The cold-air inlet, and the soil-pipes and house-drain, form one connecting system, but that part of it that is within the house must inevitably be warmer than that portion without the house, with the result that a constantly moving current of fresh air is kept sweeping through the pipes; and after doing its benign cleansing and oxidizing work it passes out at the top of the pipe, over which a network of coarse wire-gauze should be fastened to prevent the ingress of foreign bodies. Thus water and air, the two great cleansers of the world, are constantly acting on substances that otherwise would surely poison the air within the pipes—which poisoned air would just as surely find its way into our apartments.

It will be noticed that every fixture that is connected with the drain has its own independent "trap" or curve beneath it, so arranged as to retain constantly a portion of water that is technically called its "seal." This is the great reliance for keeping foul air, disease-germs, and all manner of hurtful things from entering our houses. A pipe, called an "air-pipe," is made by suitable connections formed at the rising curve of each trap, to act as a preventive of emptying traps by siphonage; i. e., the water is swept out of the trap by suction, when a large body of water from a fixture higher up on the same stack rushes past it. In the diagram above, the water that is being run off from the bath (*B*), as it rushes past the point

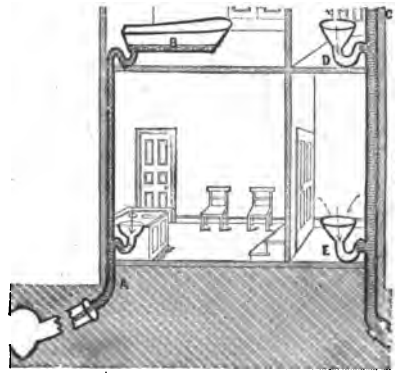


FIG. 19.—Traps being siphoned out.

where the basin-pipe enters the bath-waste, sucks the water out of it, leaving it open to the drain till more water is let in. It is an accident very liable to occur under many separate circumstances. The remedy is in these air-pipes, which, too, are found to act most perfectly when enlarged a little as they pass out at the roof.

Under all ordinary circumstances it is better not to have a refrigerator connected with any drain or sewer. The waste water can be emptied by hand daily, but in hotels and extensive establishments the wastes should be most carefully guarded by an arrangement that is equivalent to a succession of mechanical traps. Cases of decimating disease from this source are recorded in the note-books of sanitary engineers, called in to ferret out the cause, and that too in "palatial mansions"; in fact, their very "palatialness" has led to large refrigerating-rooms, filled with provisions, becoming the means of fatal disease. The very object of the refrigerator being to preserve food and drink, it is a poor plan to neutralize its primary purpose by placing it in direct communication with the source of every sort of mold and decay.

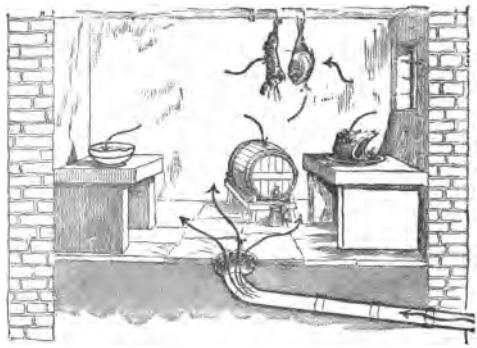


Fig. 20.—A refrigerating-room communicating with drain.

Observe that each closet and the slop-hopper is provided with a separate cistern for flushing the fixture to which it belongs *only;* by this means the general water-supply of the house is kept purer; if any one wishes to learn how, it is fully explained in Mr. Gerhard's manual.

In houses that are liable through any cause to an intermittent supply of water, there will generally be a tank, and

in country houses, where rain-water from the roof is stored, we find them, and because "out of sight is out of mind," they have been allowed to become fetid from want of cleansing, while in both city and country, through unaccountable carelessness, their overflow-pipes have been thoughtlessly connected with the nearest soil-pipe, or possibly a perfectly unventilated cesspool. Here is what is to be found in thousands of country houses: There is a tank in the attic, and a large cistern, perhaps in the cellar, perhaps just outside the walls; the overflow of the tank conveys the water into the storage-cistern, which again has an overflow-pipe discharging into an unventilated cesspool. Of course, there is no exit for the foul gases generated there save by the route indicated by the arrows in the diagram, and the currents produced by the fires in the house will be sure to draw these gases into the living-rooms. An eminent sanitarian estimates that more than one half of all domestic storage-tanks will to-day be found with overflow-pipes so arranged as to conduct sewer emanations directly into them.

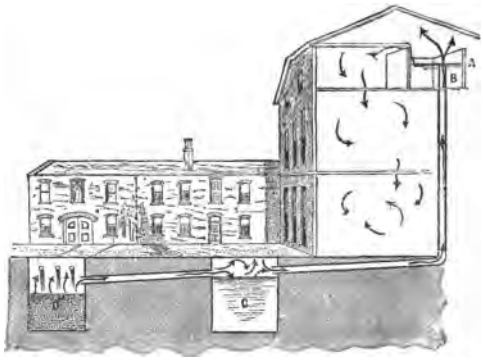


FIG. 21.—Tank and cistern, with overflow into cesspool.

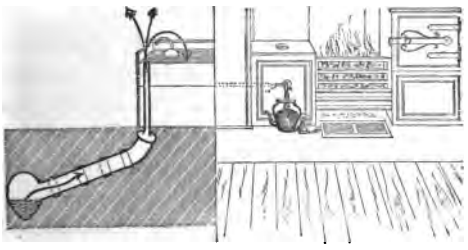


FIG. 22.—Tank feeding kitchen-boiler, with overflow into cesspool.

The tank of our model house discharges through a well-trapped pipe into the rain-water leader. It is aside from the purpose of this book to pronounce in favor of this or that fixture, of which the number is legion. Each week sees many patents issued, but, as every detail of these is carefully discussed in a book that costs but fifty cents, no one who wishes to inform herself need remain ignorant.

In general, it may be said that the drift of evolution in sanitary appliances is toward greater simplicity of form, and greater strength and durability of materials, while the thoroughness of workmanship demanded in adapting them to their purposes would have been regarded as a needless waste of time and money twenty years ago. The old-fashioned pan-closet had twice as much mechanism before a pipe was attached, as its cleanly modern substitute needs to reach the street-sewer. The annexed diagram might be aptly named simplicity *versus* complexity.

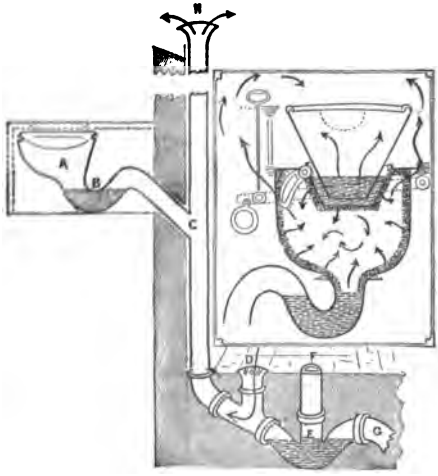


FIG. 23.—Right: the antique "pan-closet"—the sanitarian's horror. Left: its modern substitute.

There is no fixture that needs to be more carefully planned and watched than the slop-hopper. These are now made of a single piece of earthenware, and so as to combine house-maid's sink and hopper in one, and, the same cleanly, non-absorbent material makes the best kind of stationary wash-tubs; while an iron enameled bath-tub, standing up from the floor, is a most cleanly fixture. Safe-wastes are a necessity in houses where "eternal vigilance" is likely to be wanting, and even

well-watched houses have had an occasional flooding. They should never be connected with the drainage system, but should discharge over a sink.

There is a growing fashion of arranging all fixtures in what is called the "open" manner, i. e., with no wood casings about

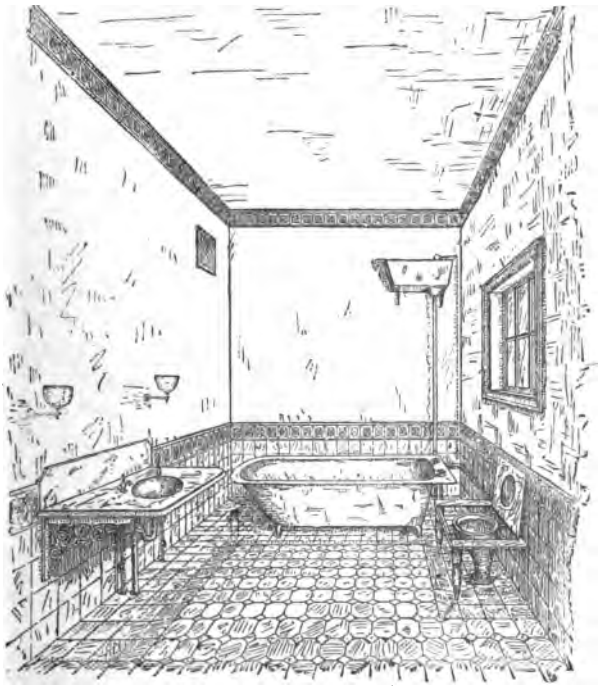


FIG. 24.—Bath-room fitted up in the open manner. (From Gerhard's "Drainage and Sewerage of Dwellings.")

them at all. The bath-tubs stand upon feet, the lavatory-slabs are supported on metallic brackets, and the whole arrangement leaves no dark corners to become filthy. Of course, polished brass pipes have a certain elegance, but plain, well-made leaden ones have no occasion to be ashamed of themselves.

The illustration shows a bath-room with water-tight floor

of tiles laid in concrete, that portion of it which comes under the fixtures sloping enough to give an easy incline to any drippings from the fixtures, or any overflow, while this entire part has a pitch toward a point at the left of the bath, where a drip-pipe leading down to discharge over a basement-sink is inserted, and its inlet is covered by a plated strainer. The whole constitutes a most efficient substitute for the several

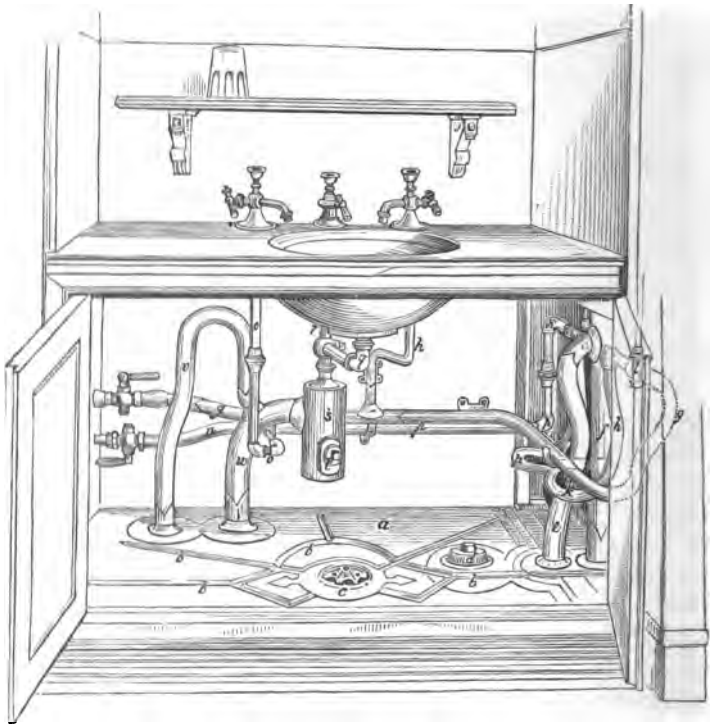


FIG. 25.—Plumbing-work under a basin in William K. Vanderbilt's house.

safe-wastes that would usually be required in such a room. The illustration (Fig. 25) shows very elegant and expensive work done in this style.

The present perfection in plumbing has not been reached

without a multitude of mistakes; a vast deal of supposed knowledge has had to be unlearned. Fig. 26 is an example of what "The Sanitary Engineer" calls a typical basin, so almost

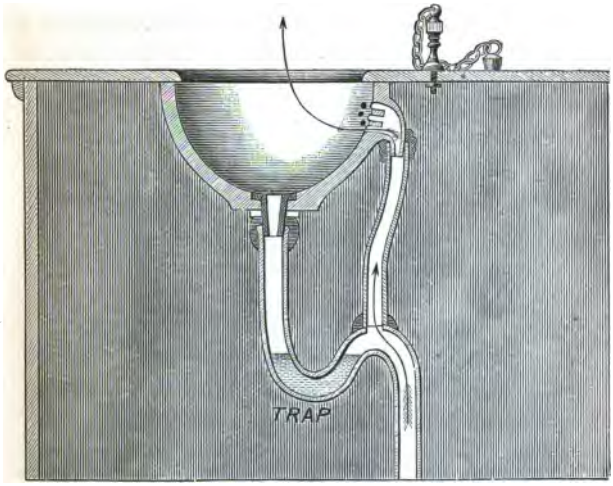


FIG. 26.—A typical basin. ("Sanitary Engineer.")

universal was this method of arranging the overflow from these. Fig. 27 is an example of what the same publication calls "a worse than useless trap." The pipe from the basin is supposed to extend down into the "round" or "bottle" trap, as shown by the dotted lines. The overflow-pipe entered the trap above the water-line, at the same level as the outlet, as shown, and the plumber who discovered and reported the case stated that there was a draught out of the overflow strong enough to blow out a candle. When a representative of the "Engineer" was sent to verify the matter, he found the overflow closed by paper pasted over the overflow to keep out the "bad smell."

The person who has carefully followed the foregoing will perhaps find it useful to study the two following contrasted diagrams (Figs. 28 and 29) by way of review.

There are probably few houses that were plumbed more

than five years ago where, although built in the best light of that time, one or more of the objectionable features here illustrated can not be found to-day.

But suppose that a house has been very perfectly plumbed, and that the general supply of water fails or is greatly diminished for a long time. In houses unprovided with a pump to

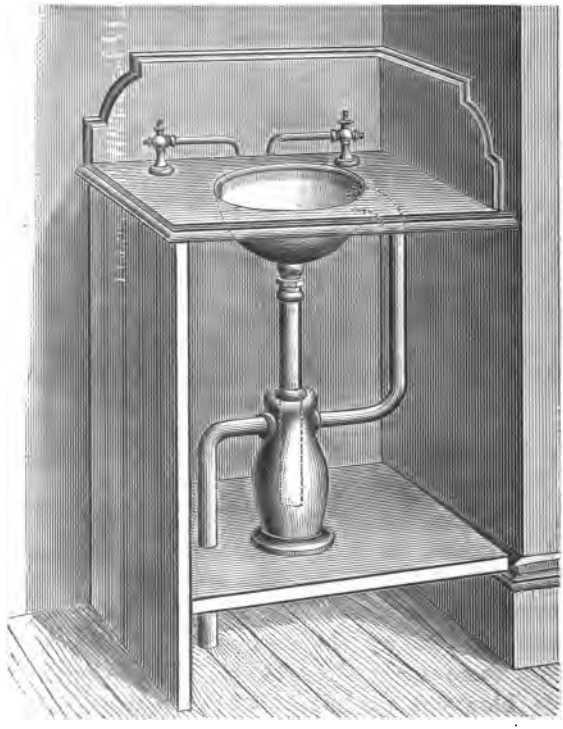


FIG. 27.—A worse than useless trap. ("Sanitary Engineer.")

bring water to the higher floors, the traps must necessarily dry out, with consequences that need not be enlarged upon. Where there are long-unused fixtures in vacant rooms, and where families leave their houses a long time unoccupied, the same consequences must ensue. Some of the unaccountable

visitations of sickness in families, immediately after returning from the country, may perhaps be explained by a want of care in airing the house, flushing all the pipes, and purifying generally before taking up their residence anew.

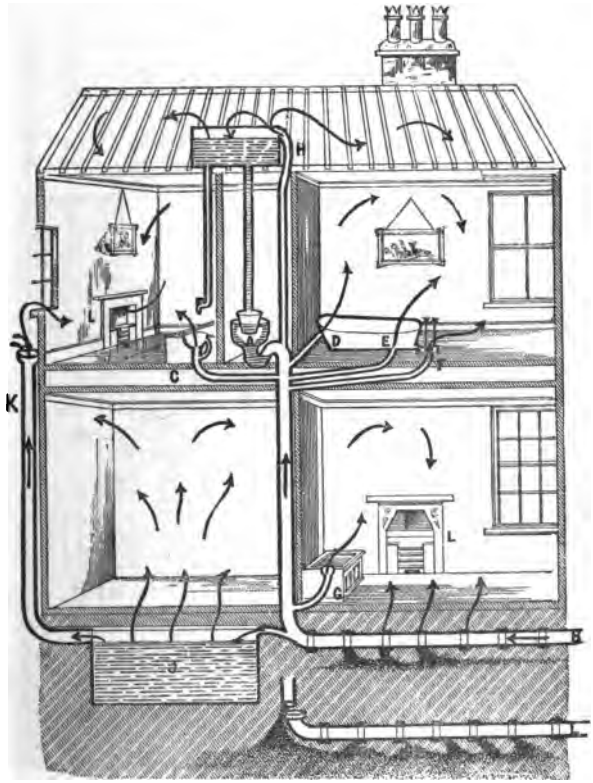


FIG. 28.—House with every sanitary arrangement faulty.

Houses that are left closed for part of the year are often found with lead pipe gnawed through by rats; and a very common piece of "scamping" is to allow a small, ostentatiously trapped pipe to pass through the kitchen-floor into a much

larger drain-pipe, with no pretense of cement at the joint, with the result shown in Fig. 31.

Plumbing Repairs.—No sooner is a system of pipes, however perfect, completed, than they begin to corrode, to rust, to decay, in some instances with astonishing rapidity, and, where

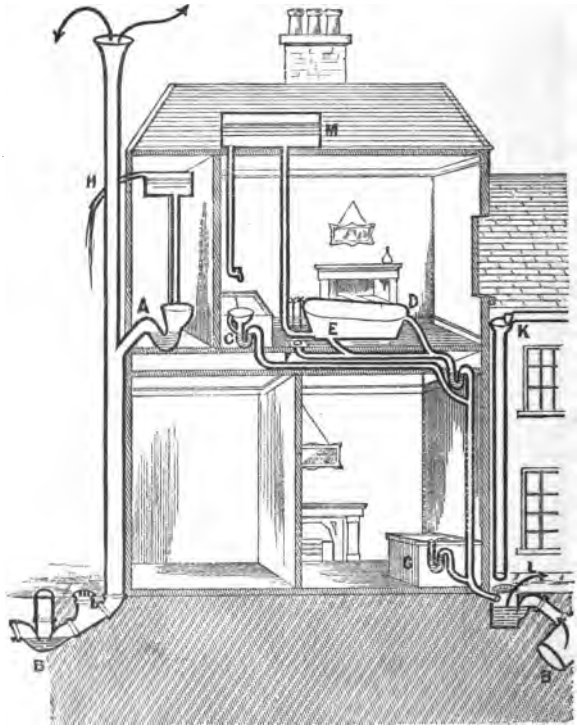


FIG. 29.—House with all the faulty arrangements avoided.

they are concealed in walls or by wood-work, the mischief they can work unsuspected is well illustrated by the following experience, copied from the London "Builder" of January 26, 1884:

"**Fungus in a Library.**—A singular instance of the havoc among books, which may be made by the growth of fungus,

was brought to my notice recently. An outer pipe becoming choked, the water it should have conveyed ran down the wall outside. The leakage was not discovered till the wood-work and shutters of an adjacent window began to crack and start, being forced out by the growth of an enormous fungus between them and the wall. When the presses and books near the wall were examined, the former were found to be strained and loosened, the latter covered with a coating of brownish fungus three to four inches thick, which fastened them to other books so attacked, and to the shelves of the book-cases. On trying to open the books, most of the leaves were found so firmly glued together by a white, silky, sporadic formation, in shape somewhat like seaweed, that attempts to separate the leaves without tearing them were futile. Hundreds of pairs of leaves, in books two or three feet from the wall, were thus penetrated; and, thin as was the coating of fungus,

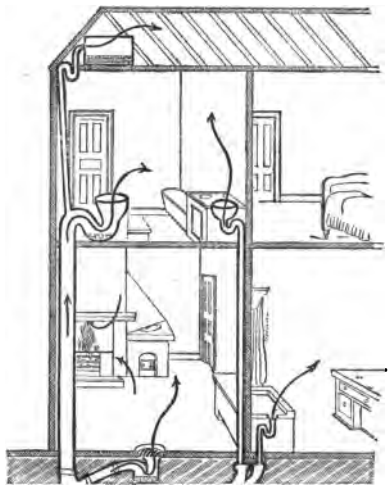


FIG. 30.—Unused traps, with water evaporated.

FIG. 31.—Rats!

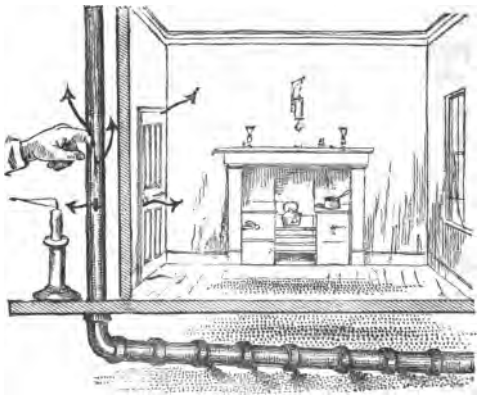


FIG. 32.—Corroded lead pipe.

it almost obscured the letterpress, and, of course, ruined the plates. The most effectual way to repair the damage appeared to be to thoroughly clean the fungus from the exterior, and expose the books to a gentle heat till the damp was expelled. Though the books could then be opened and read, many were irremediably injured. The rapidity of growth of this fungus was remarkable. For the sake of experiment *in corpore vili*, a book, after being treated as above, was replaced. In three days the exterior had acquired a coat of fungus about an inch thick; the book was fixed on the shelf, and the leaves refused to be parted asunder.—Moral: see that water-pipes near a library are not choked."

Also, observe the certainty with which a study, arranged as in the cut, when the soil-

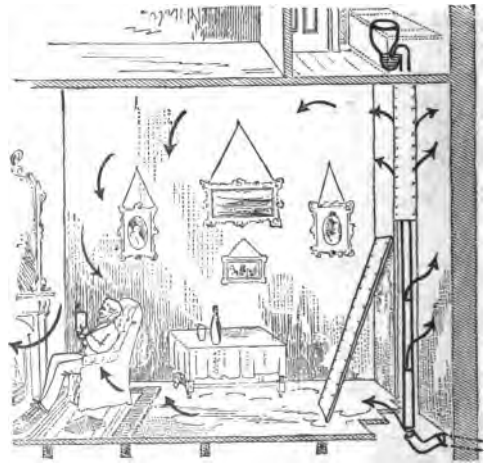


FIG. 33.—Soil-pipe concealed by a board, and parted from the trap.

pipe, which had been "let in" to the wall, became perforated, must have poisoned the air. This also shows one of the commonest failures in drains; all sanitary inspectors testify that the commonest accident is this—solution of continuity just where the pipe should unite with the drain.

When repairs are necessary, most likely the man who did the original work can not be found, and, if no map of the piping of the house has been preserved, he will spend more time in trying to find where the pipes lie than it would require to make many maps; and where one occupies a rented house, cared for by one of the men "handy with tools," who advertise for janitors' situations, but declare themselves capable of attending to "all plumbing repairs," one should be wary. That the head of a family should *know* the state in which things are left after repairs, is well shown by this:

A tradesman in New York city, who was a stalwart and robust man—in fact, had never been sick—rented a comfortable house in a not at all fashionable quarter of the city, and here lived with his wife and six children. The waste-pipe from the kitchen-sink became obstructed; the plumber was sent for. The sink had the usual inclosed space, called the sink-closet, through which passed the waste-pipe. In this case the plumber had contracted to keep all the houses in the block in order, and he wasted no useless minutes in earning his money. Plunging into the darkness of the closet, he made an opening into the pipe, inserted a cane, pushed out and forward a large amount of grease, etc., poured down some concentrated lye, and went

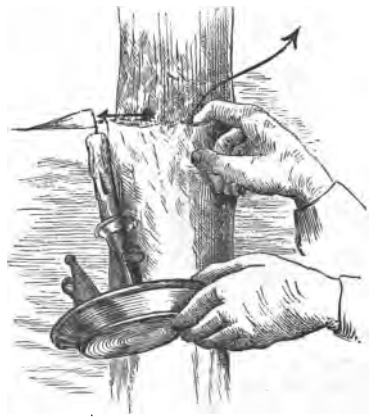


FIG. 84.—Putty joint.

away. This was in July. The family soon left the city for the country, and, closing the house meanwhile, remained away for six weeks. When they returned the house seemed "moldy and musty," but they had expected that. By keeping the windows and doors open they soon remedied it, but at the end of December there was a cold spell of such severity that the house was kept tightly closed. One after another of the children sickened with diphtheria; the father had unmistakable malarial fever, and in one week three of the children died. The servant was ill, but recovered. Examination showed that the plumber cut a hole into the kitchen waste-pipe, and left it open. An epidemic of diphtheria was prevailing in the city, and no one need ask, "How came these people sick?" The father is still a victim to recurring attacks of malaria, and the word "plumber" sets him into a paroxysm of invective. "Yes, they are a nice set," he says; "I hired a plumber to kill me. Before that one let the poison into my house, I never was sick; now look at me!"—he does look sick—"and it has taken all I can make to pay doctors' bills from that day to this." This is only one of thousands of cases. Pipes have been "repaired" by tying old rags about them, by using putty to fill the joints, or cement that can be peeled off by a penknife. They have been found with strips of sail-cloth tied on with twine, with a large length of pipe slipped over two adjoining ends of small pipe that did not meet, "sleeve"-fashion, and the interval between the smaller and larger stuffed with paper or mortar. In the house whence this specimen was taken all the joints between the lead pipes that measured one and a quarter inch, and iron

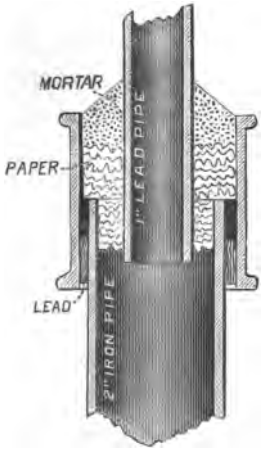


FIG. 35.—Specimen of plumbing taken from one of a block of houses building in New York in December, 1882. ("Sanitary Engineer.")

pipes that measured two inches, were made with paper and mortar.

Beware of "Dummy" Pipes.—In leasing a house the tenant can not be too thorough in investigations, to ascertain that pipes and fixtures do the work which it is alleged they do. In a block built by a "jerry" in New York two years ago, a show was made of flushing all the closets from a tank located above the highest, but it was found that though the tank was duly in position, the down pipe which should have gone from top to bottom of the building *ran down only to the ceiling of the room below that in which the tank was located, and its end was soldered up.*

The "Metal-worker" relates the following: "A man living in Brooklyn was troubled with bad odors in his house and sickness in his family. The man who owned the house had evidently been aware of the requirement that "the soil-pipe should extend of undiminished size at least two feet above the roof." The anxious tenant was advised to determine whether his soil-pipe was tight, and the use of peppermint was suggested. He procured some and went to the roof, for the purpose of pouring it down the pipe through the projecting extension, his wife and others being stationed at different points in the house, to see if they could detect the smell at any of the fixtures. As they could not, it seemed as if the test had failed to show any defects in the pipe system, but in a few minutes all the oil of peppermint which had been poured down the pipe came through the ceiling of one of the bedrooms on the highest floor, and dripped down upon the carpet. Examination revealed the fact that the supposed ventilating extension of the soil-pipe above the roof was a mere sham. The plumber had put on a length of pipe, and secured it in an upright position, but it had no connection whatever with the soil-pipe of the house."

CHAPTER VII.

SEWER-GAS AND GERMS.

Sewer-Gas: why we must keep it out.—There are people who think to stay the chariot-wheels of progress by shouting, "There is no such thing as sewer-gas!" and, having shouted, they join the party of apathy; but their misleading statement is only a question of names. As to the thing meant by sanitarians when they use the word sewer-gas, there is no question of its existence. We think of the distinct gases which the chemist calls oxygen, nitrogen, chlorine, etc., and, because a certain fluid has been called sewer-gas, we mentally add this as another of the same class; in that sense science does not recognize sewer-gas, but there is a distinct and peculiar *effluvium* made up of gases, each generated by some different set of fermenting and decaying materials, and altogether forming what may be called *sewage-effluvium*, the last word meaning "that which is breathed out" or exhaled from bodies—these bodies being the numberless wastes from men, animals, and factories, that find their outlet in the sewers. Professor C. F. Chandler gives its constituents thus:

Carbureted hydrogen	72·88	in 100 parts.
Carbonic acid	13·30	"
Oxide of carbon	2·54	"
Sulphureted hydrogen	6·70	"
Ammonium, nitrogen, etc., etc.	4·58	"

There may be people who think that is a safe and agreeable compound to let into our living and sleeping rooms; but examine the constituents one by one: 1. *Carbureted hydrogen*, or marsh-gas, is formed at the bottoms of muddy pools and ponds, but most abundantly in coal-mines, where it consti-

tutes the fire-damp, which, when casually ignited, causes the destructive mine-explosions that occasionally horrify us. 2. *Carbonic-acid gas:* we are always hearing about this as a poison. It is what a misanthropic Frenchman depends upon to kill him, when he shuts himself up with a lighted charcoal-furnace. 3. *Oxide of carbon:* this unites with chlorine, forming a pungent, suffocating compound. 4. *Sulphureted hydrogen:* this is powerfully narcotic, and smells like ancient eggs. 5. *Ammonia:* irritating and asphyxiating. These are the things "breathed out"; this is the mixture that we are asked to believe can be innocently admitted to the interiors of our houses.

It is computed that twenty-eight persons are made invalids by unsanitary surroundings where one dies. *Malaria*, bad air, is the popular name given both to this effluvium and to its train of headaches, chills, and neuralgias; but worse remains behind, for the deadliest emanations from the sewers are undoubtedly those disease-germs, organisms now dividing the scientific world as to their origin, but of whose existence and deadly work nobody entertains a doubt.

FIG. 36.—Microscopical view of sewage sediment: 1, fungi; 2, 2, vorticellæ; 3, probably epithelium; 4, 4, diatoms; 5, 5, 5, confervæ; 6, mycelial filaments; 7, sporules; 8, cellular organism; 9, amœbiform body; 10, korona; 11, vegetable matter in process of decay; 12 (?); 13, actinophores; 14, rotifer; 15, large fungus apparently in the process of growth; 16, bacteria. Certainly a not very pretty swarm to invite into one's parlor.

Disease-Germs.—Five years ago it would have been presumptuous to declare unqualifiedly that typhoid fever, diphtheria, cholera, and all the diseases that become epidemic, are produced each by its own specific *contagium*, which consists in

an infinitesimal *seed*, capable of retaining its vitality for an indefinite period, and which can be borne around the world without losing the power to spring into life, once it meets its appropriate soil; this found, it germinates, passes through its various phases of development, and ripens, "yielding fruit after his kind, whose seed is in itself"—the old announcement, in Genesis i, 11, being an exact statement of the results of the highest scientific research of this latest hour of the present day, and that these "seeds," "organisms," "spores," "contagia," or by whatever name called, will, when introduced into the body, again produce each its own disease "after his kind," unless meantime they have been subjected to the action of some substance or force capable of destroying their reproductive power. But now, thanks to the researches of Pasteur, Tyndall, Koch, Virchow, and an army of others, burning with scientific zeal, and spurred on to the greatest exertions by the unsparing criticism of able men committed to adverse theories, we can say, in the words of Tyndall: "Sow small-pox in the human body, your crop is small-pox; sow there scarlatina, and your crop is scarlatina; sow typhoid virus, your crop is typhoid; cholera, your crop is cholera. The disease bears as constant a relation to its contagion as a stalk of wheat or a thistle does to its seed. With analogies so obvious and striking, it is no wonder that the conviction is spreading and gaining daily in strength, that reproductive parasitic life is at the root of epidemic disease; that living ferments, finding lodgment in the body, increase there and multiply, directly ruining the tissue on which they subsist, or they destroy life indirectly by the generation of poisonous compounds within the body. This conclusion, which comes with a presumption almost amounting to demonstration, is clinched by the fact that virulently infective diseases have been discovered with which living organisms are as closely and as indissolubly associated as the growth of torula with the fermentation of beer."

In March, 1882, Dr. Koch addressed the Physiological Society of Berlin on "The Etiology of Tubercular Disease," and Mr. Tyndall hastened to give an account of the address

to the London "Times": "Koch says one seventh of the deaths of the human race are due to tubercular disease"; prior to him it had been placed beyond a doubt that consumption was communicable. It was his aim to determine the precise character of the contagium, which previous experiments on inoculation and inhalation had proved to be capable of indefinite transfer and reproduction. He subjected the diseased organs of a great number of men and animals to microscopic examination, and found in all cases the tubercles infested with a minute, rod-shaped parasite, which, by means of a special dye, he differentiated from the surrounding tissue. It was, he says, "in the highest degree impressive to observe in the center of the tubercle-cell the minute organism which had created it." It would take too much time to describe the severe processes by which he excluded all possible sources of error, but, as consumption spares no race or climate, here is a paragraph which concerns every woman in the world: "In a vast number of cases Koch has examined the matter expectorated from the lungs of persons affected with phthisis (consumption), and found in it swarms of *bacilli*, while in matter expectorated from the lungs of persons not thus afflicted he has never found the organism. The expectorated matter in the former case was highly infective, nor did drying destroy its virulence. Guinea-pigs infected with expectorated matter that had been kept dry for two, four, and eight weeks respectively, were smitten with tubercular disease quite as virulent as that produced by fresh expectoration." Koch points to the grave danger of "inhaling air in which particles of the dried sputa of consumptive patients mingle with dust of other kinds."

The microscope has revealed an organism which appears in the blood at a certain stage of the relapsing fever, which is called the *spirochette*, from its spiral motions. Dr. Brown, of Louisville, found *vibrios* (from vibratory motion) in the blood of yellow-fever patients in 1878; for these infinitesimal organisms, each but the $\frac{1}{3000}$ of an inch in diameter, and requiring a magnifier of 1,200 diameters to investigate, have as different styles of progression as an elephant and an antelope.

Dr. Salisbury, of Ohio, found peculiar and characteristic organisms in the perspiration of persons suffering from fever and ague. Pasteur finds one sort of spore in the blood of animals suffering with splenic fever, and another in that of chickens suffering with cholera; in short, the drift of research all points to the establishment of the fact that most of the contagious diseases are caused by a parasitic growth in the blood of the victim, which parasite is produced by the direct implantation of its seed in the system; and Pasteur solemnly announces his conviction that "it is within the power of man to make these parasitical diseases disappear from the face of the earth."

Not every kernel of corn planted in a given field will germinate; so not every disease-germ, swallowed or inhaled, will develop. The *germ itself must be in a proper state of preparedness.* What this is will be discussed later, but, having caught this vegetative vigor, it runs its course, and right here lies the explanation of its fatal results in the most robust and muscular, where in an epidemic it often occurs that those popularly called "full-blooded" succumb, while feebler subjects survive. The reason why typhoid fever is in many cases such a swift destruction will perhaps be better understood by computing the number of animalcules which are produced by the repeated "segmentation" of the parent into two, which takes place before it is an hour old, while it is changing the very nature of an albuminous fluid. Then each segment divides into two, and at the end of twenty-four hours the first tiny enemy of man has become more than sixteen millions, or, to be exact, 16,777,266! Think of a man carrying such a swarming horde in his blood—the devouring brood of a parent so small as to be seen only by the most powerful microscopes!

Typhoid Fever from Contaminated Well-Water.—Facts are more convincing than assertions, and they point the way of escape from danger. Dr. Austin Flint carefully studied an outbreak of typhoid fever, and reported its effects, in 1852; he evidently had at that time a prophetic glimpse of the nature of contagia, and he has lived to see that the views that then commended themselves to his philosophic judgment are at the

present moment advancing with resistless momentum among the members of the medical profession.

Dr. Flint says: "In a small, isolated community, consisting of nine families, at North Boston, Erie County, New York, typhoid fever had been unknown till the autumn of 1843; indeed, the disease was not known to have occurred in any part of the county up to the time mentioned.

"On the 21st of September of that year, a young man from Warwick, Massachusetts, being on a journey westward, took lodgings at the tavern in North Boston, kept by a man named Fuller. He had been ill for several days, undoubtedly laboring under typhoid fever. He died on the 19th of October, at the tavern which was the daily resort of the members of seven families, with one exception living within a few rods of each other. One family, consisting of several persons, was on terms of hostility with the innkeeper, and so all intercourse was precluded. Twenty-three days after the arrival of the stranger, two members of the innkeeper's family were attacked with the disease from which he suffered. Subsequently five other cases occurred in this family. In all the other families, with the one exception already noted, cases more or less numerous were noted within the space of about a month from the date of the case first developed after the stranger's arrival; and during this period more than one half the population became affected. The family in which no case occurred was the only one of the seven which was not brought into direct contact with the disease. So extraordinary was this outbreak, that the popular opinion in the neighborhood was that the head of the family in feud with Fuller, the innkeeper, had *poisoned* a well used daily by the latter and by six other families, of which five were attacked." Chemical analysis at Buffalo showed this to be *remarkably* pure. If one is disposed to ask why one of the visiting families was exempt, there is a very probable explanation in the fact that there are whole families who drink tea or coffee, for which the water is boiled, whereby disease-germs are killed, or use cider or stronger beverages. It is not uncommon to meet rural households not one of whom ever

takes water "neat," and it is one of the commonest observations on waters that have been proved to have caused epidemics, "very sparkling and clear."

Epidemic of Typhoid at North Tawton, England (Dr. Budd).—In England there was a man endowed with the clear insight of genius, who very early saw with a prophetic glance the truth of the germ-theory and all its bearings. He was a hard-working country practitioner, removed alike from the stimulus and applause of the metropolis, but he observed, he diligently collected and collated facts, and, though opposed in belief to almost the entire medical faculty, he never for an instant lost his ineradicable conviction that typhoid is a parasitical disease, that all life comes from some preceding life, and that all those growths that constitute the separate varieties of what are called blood-poisons, however they may once have originated, are only propagated by the law of continuous succession. Does the reader ask whence came the *first* spore or seed? A sufficient reply, as far as this theory goes, is, "Whence came the first kernel of wheat?" but the answer, in which many millions of sweet-souled men and women have rested, is: "And God said, Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so" (Genesis i, 11).

This earnest seeker after truth lived and worked at North Tawton, a rural community, but he left the fruit of his life-work in a book from which we see that he knew that typhoid fever is one of the preventable diseases. In England the deaths from it are 15,000 per annum—equal to an entire town. Should the news go forth that any town of that number of persons had been swept off by a tidal-wave, and not one had escaped, what a thrill of horror would electrify the country! but for every one who dies among persons attacked, nine recover; so that in England, where, owing to thorough registration, accurate results can be reached, it seems that 135,000 persons, a population larger than that of Louisville, Kentucky, have each endured the sufferings and the loss of time and money entailed by an attack of this disease; and as England

is to-day fifty years in advance of the United States in actual applied sanitation, a very little reflection will show what multitudes of needless victims there must be here. Dr. Budd says the sanitary conditions of the town were of the worst: nearly every house had a pig-sty, all had dung-heaps, and the privies were of the most primitive type, and neglected to the last degree, but for many years there was *no* fever; but, as soon as the *seed was brought*, the fever spread. For the development of fever a more specific element was needed than any or all of the above-mentioned nuisances, in the common course of things, were able to furnish. But *this* came. On July 11, 1839, a first case occurred in a poor and crowded dwelling. Before November 1st eighty out of a village of 1,200 had died. One of its peculiar features was the tendency to communicate itself to more than the original person attacked. Few houses where it once entered that did not have more than the first case attacked, and in some every person was sick. Dr. Budd proved its contagiousness by tracing the history of persons who went to other places. Two of these were sawyers. They lodged in a little court that was fetid and foul to the last degree. On the appearance of decided symptoms, both of these men went to their homes, in the parish of Marchand, seven miles off. The first was married; he took to his bed two days after reaching home. He died in five weeks. Ten days after his death two of his children had the disease. The other man was single, and took lodging with an aged couple (typhoid generally attacks the middle-aged). He was very sick, but got well. When at his worst, a friend who came to see him helped to raise him in bed; while so doing, he was overpowered by the smell from his body, felt ill from that time, and on the tenth day was seized with a violent shiver, which was followed by typhoid of long duration. Before he recovered, his two children, and a brother, who lived at a distance, but came to see him, were attacked. The houses occupied by these two men were some way apart, and aside from them there was no fever in that part of the country.

Case II.—"A widow named Lee lived in North Tawton.

She began to droop on August 20th. On the following day, not knowing what was impending, she went to visit her brother in Chaffcombe, seven miles away. August 23d she was laid up. Her case was now perfectly characteristic. She had all the symptoms—nose-bleeding, spontaneous and obstinate diarrhœa, tympanitis, dry tongue, low delirium, and the now well-known eruption of rose-colored spots. She recovered, but, in a few days after she had become convalescent, her sister-in-law, who had nursed her, fell ill of the same fever, and died on November 4th. The husband, who had spent most of his time in the wife's sick-room, began to droop on the last day of his wife's life, and, after lying ill a long time, recovered. While he was yet ill, three weeks from the date of his attack, one of the farm apprentices was attacked in the same way. Then followed a lad employed as a laborer on the farm, and then Miss Snell, who had come to take charge of the house after Mrs. Snell's death. Next in order came another apprentice, and again, as a last group, a servant-man, a servant-girl, and another young person (a daughter of Mrs. Lee), who had, until she was laid up, acted the part of a nurse." Says Dr. Budd: "As far as external conditions went, the sanitary state of the homestead which had become the seat of this terrible scourge, differed in nothing from what it had been for many years before, during which the household had continued to enjoy perfect health. The only new incident in its history was the arrival of Mrs. Lee, from her infected village, seven miles off, with the fever upon her. What, perhaps, is still more to the point is, that many other such homesteads lay near to this one which were far worse off in respect to the same conditions, but in which no fever of this or any other kind existed; there was no single case of the sort, indeed, within miles of the place, or nearer than North Tawton, whence the taint had been imported. The outbreak, severe as it was, did not end here. In order to lighten the burden of so heavy a sick-list, the servant-girl, already referred to as one of the sufferers, was sent to her own home, a small cottage in the hamlet of Loosebeare, as soon as the symptoms of fever appeared. Here she lay ill for

some weeks under my care. Before she had recovered, her father, a farm-laborer of the name of Gibbings, was likewise seized, and narrowly escaped with life. A farmer named Killand, who lived across the street, and who visited this man several times, was the next to take the disease. His case was in turn followed by others under the same roof, and the fever, spreading from this to other houses, became the focus of a little epidemic, which gradually extended to the whole hamlet. Scattered over the country-side there were some twenty or thirty other hamlets, with the condition of which I had long been intimately acquainted. From the soil of all were exhaled the same putrescent odors, and yet while at Loosebeare a large proportion of the inhabitants were lying ill of fever, in not one of these was there a case. To explain the contrast, there was but one fact to appeal to, the arrival from Chaffcombe of Mary Gibbings with the fever upon her. Before that event, in spite of pig-sties and manure-heaps, Loosebeare was free from the malady. The diseased intestine of the girl had continued to deposit its morbid excreta two weeks on the soil before it spread, and then the cases sprang up immediately around her person. The Chaffcombe tragedy had yet another episode. One of the boys already mentioned went to his village, when he gave it to his mother, who died; to his married sister, her husband, and two children; to another married sister, who came to visit the first, she being on her return home, the means of spreading it in still another quarter, an account of which would be merely a repetition of the preceding. All these cases were either under my care or that of my brother. We kept accurate records of all the cases, with the express view of showing its mode of spreading."

Dr. Budd also has accurate records of many other cases that substantiate his position. One of these throws much light on such outbreaks as are occasionally known, and seem unaccountable—and would be such if no persevering investigator followed them up. In a country inn at Cowbridge, in Wales, the race-balls were held; these were attended by a large number of young people of the region, and many of them partook

very freely of lemonade, which was furnished by the proprietor of the hotel. In a week's time between forty and fifty were down with typhoid fever. Investigation revealed the cause. A few weeks before a stranger had come to the inn, and immediately became very ill with typhoid fever, a fact carefully concealed, so as not to injure the custom of the house. The well which supplied the water was near the leaky vault into which the dejections of the sick man had been thrown.

The clearly proved instances of the production of typhoid fever by drinking contaminated well-water, to be found in sanitary reports abroad and in this country, now amount to many hundreds, and the number of victims would mount up into the thousands.

Typhoid Fever in the City of New York in the Autumn of 1883.—A very unusual number of cases of this disease led Dr. E. G. Janeway to make an extended investigation, the results of which are summed up in the "Medical News" of February 23, 1884; and as the principal causes of the diffusion of the disease are not only still operating, but likely to be greatly aggravated before any permanent relief will be obtained, some extracts from the article will not be uninteresting: "The principal source of typhoid fever is to be looked for in the defective sanitary arrangements, permitting the contamination of air or drinking-water by sewer emanations. Any one who has examined much the sanitary defects, in cases of typhoid fever, will find that vitiation of water is in many cases possible, especially at the present time, with our defective water-supply and water-pressure. The drawing of water on the lower floor causes a partial vacuum, which, if stop-cocks are open, or if tanks supplied by ball-floats, which open the pipe when the water is lowered, are more or less empty, or by defective valves to pipes on water-closets with direct supply, causes an aspiration of air into the house. The same danger exists through the overflow-pipe of tanks when they discharge into sewer-pipes." Two outbreaks in institutions were traced to this cause. "The number of leaky vaults attached to tenement-houses in New York is beyond the belief of those per-

sons who, living where only the best sanitary appliances are used, have an idea that nobody uses those mediæval things now; and there are also still, both in built-up New York and also in the suburbs, many wells. Thorough experiments demonstrated that a drain which seemed sound certainly did allow its contents to penetrate to the well of an institution where there were many cases of the disease. Analysis of the water did not show it to be unusually impure, but chloride of lithium, dissolved and poured down the sink of the institution, made its appearance in the well-water, showing a communication that could not be found by ordinary methods; and by discontinuing the use of the well, and confining the inmates to Croton, the epidemic died out." Dr. Janeway continues, in a series of conclusions, that "this virus is certainly contained in the discharges from the bowels, and that it gains entrance to the system through the air coming from places into which the discharges of other typhoid-fever patients have been deposited, or through water contaminated by a similar process, or through milk diluted with contaminated water, or perhaps vitiated by contaminated air." The failure of the disease to spread where prompt and thorough disinfection of excreta and garments has been practiced, leads Dr. Janeway to suspect that "it is not communicated by the breath and perspiration." There seems little doubt that a person has typhoid fever but once, and thus it is possible to procure nurses that are "safe," and it can be stamped out where it originates.

Impure Ice.—As it has been abundantly proved that freezing does not take out the impurities of water, neither does it destroy the vitality of many germs, the importance of knowing that the source of ice-supply has not been contaminated is self-evident.

Scattering Schools when infected with Contagious Diseases.—In 1826 the military school of La Flèche was invaded by typhoid fever. One hundred and nine students had it within the institution; twenty-six were scattered to their homes, being apparently well when sent there. *All had it.* So that parents should consider that there is a period of incubation,

and not be deceived by it; yet one of the commonest items in the newspapers is, that there has been an outbreak of scarlet fever, or diphtheria, or typhoid, in a school, "and the pupils were immediately dispersed to their homes." If there are fifty of them, they go in fifty directions to set up in fifty new places centers of infection. It seems as if doctors who abet this action ought to be made chief officers of a Society for the Diffusion of Contagious Diseases. On December 16, 1858, William Phillips was brought home from Cardiff, where he was at boarding-school, with typhoid; from him eight persons took it, and four died. Instances of such wholesale infection are no doubt only to be met with under particular circumstances of time, place, habits, and life. Probably all emanations from a person sick of a contagious disease are infectious, but in small-pox we know that the pustules contain the virus. In typhoid fever we have only to picture the eruption as being on the inner surface of the intestine. It has been known to be acquired in many other ways than through drinking-water, but, when it is contracted in this latter way, the period of incubation is very short—generally not more than four or five days—which is a strong confirmation of Mr. Tyndall's remarks on *the state of preparedness of the seed.* The wide-spread ruin that can come from *one* infected person is most vividly set forth in an exhaustive investigation made by Dr. Thorne Thorne, of London, and printed in the "Ninth Annual Report of the Local Government Board" in 1879. The demonstration was complete that an outbreak at Catersham and Redhill, that lasted six weeks, in which three hundred and fifty-two persons were attacked, and twenty-one died, came from drinking water contaminated by the discharges of one enteric-fever patient—and he not so sick as to be in bed!

Checking the Spread of Typhoid Fever.—In combating the spread of the disease, it must be remembered that perhaps all the emanations from the patient are more or less infectious, but the most virulent come from the intestine, and that it spreads where no provision is made to keep them from contaminating air and soil. In towns the system of water-carriage

is the great protector of the people, but it is almost impertinent to point out the need of traps on waste-pipes that go to a sewer, and it is easily apparent where some of the "sporadic" cases can originate. The immediate attendants may escape, and people at a distance suffer, so the opponent of the contagion theory denies the existence of the seed, "which," says Dr. Budd, "is much the same as to argue that, because the next successors of yonder tuft of rushes do not spring up immediately around it, the spores it has committed to the stream are sterile, and that it is not in the nature of rushes to multiply at all." How should we proceed if we wished to make sure that no rushes should ever grow from that particular tuft? Destroy the seed, and this contains the whole secret of disinfection. All linen used about a patient should be put into a solution of chloride of lime, or chloride of zinc, and *boiled.* Chloride of lime should be put about the room in large quantities. People generally have very inadequate ideas of the quantity of disinfectants needed to insure the destruction of the germs. In one outbreak in England nine hogsheads of the solution of chloride of zinc, made in the proportion of one to forty, was used. There should be a large can, kept supplied with a solution of copperas, one and a half pound of copperas to one gallon of water, or one quart of carbolic acid in fifty parts of water. One of these solutions should be put into the night-pan before use each time. *Disinfect the discharges before they leave the sick-room* should be the invariable rule. Flush the privy or closet three times daily with solution of copperas or chloride of zinc. Keep a basin with solution of chloride of lime, and another with fair water for the nurses' hands. Keep a rubber cloth on the mattress under the sheet, and, when no longer wanted, have the mattress subjected to the action of strong heat. Have, if possible, an open fireplace, and, after the recovery of the patient, subject the apartment to the fumes of sulphur.

In Liverpool, a portable chamber, heated by steam, and mounted on wheels, has been constructed, by the use of which mattresses can be safely subjected to a high degree of heat,

and thus the very poor are spared a sacrifice that often would be a great hardship.

Of course, what we most want to know, in regard to this whole group of diseases, is, *where and how the specific poisons which cause them breed and multiply*—how to prevent their entrance to the system; but if all our vigilance proves futile, as it sometimes will, how to "stamp out" the invasion in the shortest possible time.

Dr. Budd stamped out an outbreak in a large reformatory, which is another name for a prison, after a third of the inmates were infected, by vigorously attending to the above. The beds were burned.

Unsanitary Surroundings and Typhoid Fever.—Though fermenting organic filth can not generate the typhoid poison, it has a vast influence in developing the seed when once planted; it seems to aid in breaking down the envelope, and promotes its rapid growth, perhaps as a fertilizer affects a field of corn.

A Study of the Development of One Germ.—As all these germs set up an action in the blood exactly analogous to processes of fermentation that can be witnessed outside the body, and as a clear comprehension of their method of action is necessary to the understanding of many points, a brief account of their action and products in different fluids is given:

"Take a portion of any vegetable—e. g., the beet, or some grapes—crush them, add a little water, let the mixture stand a short time, then pour off the liquid, and you have the simplest form of vegetable infusion. Allow it to remain exposed to the air at the ordinary temperature, and shortly a change will be found to have passed over it, which is popularly called 'souring,' but which is *fermentation*, and takes place as follows: The air is full of microscopic 'germs,' or 'spores,' or 'cells'—the beginnings of life—which only need the right soil, or matrix, to grow or develop. Let a grain of corn remain in your coat-pocket—it will stay a grain of corn; but drop it in some fertile spot of earth, and it changes into a tall-plumed spike, bearing many thousands of similar grains. The glucose

of the infusion is related to these universally diffused spores, just as the waiting earth is to the grain of corn; and a spore which might have staid a spore a thousand years but for the infusion, finds its divinely adapted environment, lives its life, dies its death, and fulfills its mysterious but appointed part in the economy of nature. It is so small that it takes more than three thousand of them, ranged in line, to measure an inch! But seen through a glass, in which a hair looks like a liberty-pole, with alternate branches trimmed off on either side, its behavior is completely visible. One spore, having eaten its infinitesimal morsel of glucose, instantly becomes two; these, in turn, appropriate their modicum of glucose, and at once double; so that, by a swift progression, the nature of the infusion is changed—it may be into alcohol, it may be into something with boundless power for mischief, to which science has not yet fitted a name. Different forms of decaying vegetable life seem to be adapted for the nourishment of different kinds of ferments, or infusoria.

"Again: If you let a little beef's blood stand exposed to the air, an analogous change called *putrefaction* takes place in it, through the agency of a still smaller devourer, the *bacterium termo*—the albumen of the blood representing the soil. Here is Professor J. C. Dalton's description of the process: 'While actively growing in a putrefying infusion, they are in constant process of multiplication by which their numbers are rapidly increased. The multiplication takes place by spontaneous division of the cell by a transverse partition which grows across its middle. After a time the two cells thus formed out of a single one separate from each other, and each repeats the process for itself.'"

After the destructive mites have appropriated every infinitesimal particle of glucose to be found in our animal and vegetable solutions, each liquid becomes clear, and a layer of particles is found at the bottom which can be frozen into a dormant state, or boiled so that their vitality is destroyed; but as a drop one three-thousandth of an inch in diameter contains one of these tiny creatures of God, a very little of either

added to its appropriate animal or vegetable preparation at once sets up its destructive and transforming activity. We say destructive, for our infusion, though perhaps very good alcohol, is no longer harmless treacle or grape-juice; and our clarified and transformed beef's blood would constitute a very poor fluid to course through the veins and build up the tissues of the living bullock.

Blood in the living human body is a fluid rich in albumen, it is warm, and it is shut away from air, though its red corpuscles are the vehicle of immense stores of oxgyen. Pasteur has defined fermentation to be "life without air."

The Germ-Theory of Disease.—What is now known as the "germ-theory" of disease has divided the leading scientists of the world in the past into two earnestly opposing parties. The "germ" partisans claim that all communicable diseases are produced by the introduction to the body of germs (seeds) which are themselves the product of similar germs previously existing; while the anti-germ party claim that under certain special conditions some diseases can and do spring up, without the addition of this biological factor, this something that kindles vital action; that, given a certain amount of heat, moisture, and "filth," these diseases spring into existence *de novo*—in short, that there is such a thing as spontaneous generation. Names of highest scientific authority have been enrolled in these opposing ranks, but the drift of research during the last five years has turned the scale in favor of the belief that each contagious disease has its own specific germ, that reproduces it and no other, as rigidly as corn produces corn, or poppies produce poppies.

In the first century before Christ, Terentius Varro, a Latin author, in his "De re Rustica," says, "Marshy places are to be avoided, because in them there grow certain minute animals, which can not be perceived by the eye, and which, being carried in the air, enter the body through the mouth and nostrils, and produce very serious diseases." Subsequent writers often quoted it as an old and familiar idea, but it had no basis beyond that of a "happy guess," till after the microscopical dis-

coveries of Leeuwenhoek; but even then it must wait for the invention of the modern achromatic compound microscope before it could be said to be on the way to being placed on a scientific basis. Kircher, in 1659, announced that his new "Smicroscope" revealed extremely minute worms which caused the "pest," and all through the next century there were men haunted by the belief that on this road would be found the truth; and when at last an instrument was produced that could accurately reveal the differences between organisms of which it takes four thousand to make a row an inch long, and those of which only thirty-five hundred will reach as far, alert and gifted scientific men were not slow to turn it upon earth, air, and sea, and all that in them is. After the great epidemics of Asiatic cholera in 1832 and 1848, Dr. Cowdell announced his belief that it was due to a minute fungus that inhabits the rice-plant of India; and Dr. Mitchell, of Philadelphia, maintained in 1846 that malarious and epidemic fevers are due to minute fungi; but the *demonstration* by Pasteur that various forms of fermentation and putrefaction of organic matter are due to vegetable organisms first put the matter on a scientific basis.

As it is a theme which will engage the attention of intelligent minds more and more as sanitary science progresses, and as "the air is full of it," the following passage from a lecture given by Dr. John S. Billings, at the National Museum in Washington, in 1883, will convey a clear notion of the present prevailing views on the subject: "In the first place, we want some word to designate the great variety of particles which we find throughout all air and water under ordinary circumstances, and which are almost invariably present in decomposing organic matter—minute bodies, most of which are perceptible only with the best microscopes, and which present the most characteristic phenomena of life. These we call microdemes, or little living things, and under this term are included the microphytes, or little vegetable organisms, the microzoa, or minute animals, the microzymes, or little ferments, the microbes, or microbia of Pasteur, meaning, literally, little lives, the bacteria, etc. Mingled with these microdemes there are

usually other minute particles that are not living, and which may be either inorganic or organic. It is sometimes impossible to distinguish these from the microdemes, but usually the latter may be known by the uniform size and minuteness of the granules, their independent motion, and by signs of growth and reproductive division, as shown by their being found in chains or pairs. The minutest spherical forms of these microdemes are called micrococcus, or little grains; the short cylinders or rods are called bacteria, a term which is often improperly used to include the whole class. At present it is not believed that these microdemes are ever spontaneously generated, or arise from any source other than living organisms, that each has special powers, and that each can only propagate its own kind within a certain limited time."

Using the words germ and organism in their ordinary sense, the germ-theory is, "*that certain diseases are due to the presence and propagation in the system of minute organisms, which have no share or part in its normal economy.*" When these organisms are comparatively large and well known, the diseases that they produce are called "parasitic." Some of them are produced by fungi, such as some varieties of ring-worm and the so-called "liver-spots" of the skin. One variety grows in the ear, another is sometimes found in the windpipe and lungs; these are all superficial affections; the fungi do not appear to enter the blood, even in the singular and formidable fungus-foot of India, where the disease finds access through some tiny abrasion, the comparatively large threads of the fungus penetrate the foot and ramify in its tissues, finally destroying them even to the bones; it does not enter the blood, and is local, being confined to the affected foot. One important disease, due to a fungus of the nature of common mold, affecting both men and cattle, gains access to the tissues through carious teeth, and causes a tumor near the lower jaw.

"It is found that by isolating these organisms, changing their food and varying the temperature, the process of evolution and natural selection to fit them to their new surroundings goes on very rapidly, and that the result is the production of

what might be called new species, having very different habits and powers." These constitute the famous cultures or cultivation experiments.

There are two diseases which are common to men and animals, both contagious in the highest degree in their unmodified forms, and both now affording the highest proofs of the power of man to modify pestilential scourges, by the application of the results of modern discovery. These are the small-pox in man, and the splenic fever or charbon, the anthrax or milzbrand, in animals. This last has been frequently imparted to man, in whom it is called malignant pustule. It has formed a destructive pestilence among animals in Europe, and consequently has been diligently studied, and at last has been successfully combated by Pasteur. To him belongs the honor of discovering a way to rescue thousands of animals from pestilential death by a process of inoculating healthy animals with a virus which he has "attenuated"—i. e., modified by "cultivation"; by this means he produces in the animals symptoms resembling those of splenic fever, but from which the creature soon recovers, and it has meantime lost its susceptibility to the disease; the process is so analogous to the result produced in man, by inducing cow-pox in him as a protection from the more virulent but closely related small-pox, that Pasteur himself calls the process *vaccination*. He has found a similar way of combating a destructive disease of poultry, and the entire process holds the germ of a promise that all contagious diseases may be as effectually warded off as the small-pox is by Jenner's immortal discovery.

How the Disease-Germs grow.—The splenic fever has engaged the attention of Cohn, Virchow, and Koch, in Germany; Burdon-Sanderson, in England; and Pasteur, in France. By collating the work of a long series of observers, it is easy to trace the disease from the microscopical seed or spore that plants itself in the blood of the man or the animal, where it grows into a mature plant "after his kind," sustained by that blood, in which it works a vicious change, turning it into a fluid of the color and consistence of tar. Meantime the plant

has perfected millions of seeds, whereby to reproduce itself, and dies, too often killing the animal or man in whom it has found lodgment. The disease in cattle often attacks the strongest animals of the herd, who will be seized with trembling, cramp, and bloody discharges from the nose and mouth. Sometimes they die in the course of one day, sometimes the attack is more protracted. A vesicle or "pustule" appears at the crisis. The fluids become intensely virulent, so that a man has been fatally poisoned by holding a knife, with which he was skinning an animal dead of the disease, between his teeth, or by having a drop of blood trickle down his neck while carrying the diseased meat. The sting of a fly that has rested on it will cause infection, and it is the opinion of French scientists that the disease is oftener imparted to man in this than in any other way.

It comes from handling the dried hides and hair. An epidemic came from this cause in the town of Walpole, Massachusetts, in 1853, and repeated itself in the same locality, at irregular intervals, for a period of seventeen years, presenting features that were wholly inexplicable till the later experiments of Koch demonstrated the persistent vitality of the virus in one of its forms; and the history of the observation of its different phases by different men shows in the clearest manner how, by successive steps, a scientific demonstration is finally reached—how the scattered rays from many minds are at last condensed into a clear, truth-revealing beam.

In 1850 two French observers, Davaine and Rayer, noticed, in the blood of animals which had died of this disorder, small microscopic organisms resembling rods, but neither of them at that time attached any significance to the observation. In 1861 Pasteur published a memoir on the fermentation of butyric acid, in which he described the microscopical organism that provoked it. Davaine read it. Instantly it occurred to him that splenic fever might be a case of fermentation set up within the animal body by the organism observed by him. Fertile thought! Subsequent research has placed his conjecture beyond doubt. In 1874 Dr. Burdon-Sanderson gave a very clear

account of what was known up to that time about the disorder. It had been proved that the contagium would hang about a locality where it had once prevailed for years, and this seemed to show that the rod-like organisms could not constitute the contagium, because their infective power was found to vanish within a few weeks. Other facts convinced Sanderson that the virus exists in two distinct forms, the one visible and "fugitive" in the transparent rods, the other "latent," and not yet brought within the grasp of the microscope. The subsequent steps that have revealed the whole mystery have shown that the disease may be propagated in two ways, as distinct but as effectual as the propagating of poplar-trees by "cuttings" of the branches, and by the seeds of the tree—processes that lead to the same result, but by very different paths. At the time when Sanderson was writing his account, a young German physician, named Koch, was already at work applying various original and ingenious devices to the investigation of splenic fever. He studied the habits of the rod-like organisms, and found the aqueous humor of the eye of the ox to be particularly suitable for their nutrition. With a drop of this he mixed the tiniest speck of a liquid containing the rods, placed it under the microscope, warmed it suitably, and observed.

During the first two hours hardly any change was seen; but at the end of this time the rods began to lengthen, and the action was so rapid that in three or four hours they were from ten to twenty times their original length. At the end of a few hours they had formed filaments, in many cases a hundred times the length of the originals. The same filament, in fact, was frequently observed to stretch through several fields of the microscope. Sometimes they lay in fields parallel to each other, in other cases they were bent, twisted, and coiled into the most graceful figures; while sometimes they formed knots of such bewildering complexity that it was impossible for the eye to trace the individual filaments.

Had the observation ended here, the addition to our knowledge would have had little practical value—the nineteen strokes would have been worthless for the lack of the all-important

twentieth. Koch kept on watching the filaments, and after a time saw little dots appearing within them. These dots became more and more distinct, until finally the whole length of the organism was studded with minute ovoid bodies, which lay within the outer integument like peas within their shell. By-and-by the integument fell to pieces, the place of the organisms being taken by a long row of seeds or spores. These observations were all verified and confirmed by Cohn, of Breslau, and Koch proved the spores, as distinguished from the rods, to constitute the contagium of the fever in its most deadly and persistent form. There was but one way to test the activity of the contagium—inoculation of living animals. He operated on Guinea-pigs and rabbits. Using the fresh blood of an animal suffering from splenic fever, they invariably died of the same disease within twenty or thirty hours after inoculation.

He then sought to determine how long the contagium maintained its vitality. Drying the infectious blood containing the rod-like organisms in which the spores were not developed, he found the "fugitive" contagium. It maintained its power of contagion for only five weeks at farthest. He then dried blood containing the fully developed spores, and exposed it to a great variety of conditions. He again wetted it, dried it again, and after keeping that which had been so treated for four years, he inoculated a number of mice with it, and found its action as fatal as that of blood taken from the veins of an animal at that moment suffering from the fever. There was no single escape from death after inoculation with it. Uncounted millions of these spores are developed in the blood of any animal that has died of it, each of which is competent to produce it again, but to do that it must enter the blood. The "cutting" of poplar would wither beyond all hope of revivification in five weeks, but the seeds of the tree can maintain their vitality indefinitely. In France, pits in which animals dead of splenic fever had been buried, were opened twelve years after, and a portion of the dust used to inoculate animals, and the disease was just as virulent as that from fresh blood.

Baron Seebach, of Saxony, had suffered great losses by the repeated occurrence of splenic fever on his estate, and finally began to suspect that the disease was propagated from the graves of dead animals. He observed, one day, that the clover was growing with great luxuriance over a place in the corner of a field where a sheep, dying of the disease, had been buried two years before. A few days later he noticed that some one had stolen the clover which grew at that corner, and the next day a woman, one of his tenants, came to him with great lamentation to tell him that her goat had just died, and that her cow was very ill. It was found that both the animals had splenic fever, and the woman confessed that she had stolen the clover. Pasteur believes the spores to be brought to the surface by earth-worms, as he had discovered them in their casts, and thus animals eat them with their food. In America the men who handle hides often have cruel reminders that these seeds can go round the world and yet kill their man.

The money loss to France annually by this disease is $4,000,000, and in a single province of Russia 56,000 animals and 528 men died from it in three years; and in every country of Europe it is more or less of a scourge; so it is easy to see with what delight the announcement that a means of rescue had been discovered, was hailed by the millions of peasantry whose living largely depends on the health of their animals. By a multitude of careful experiments Pasteur has succeeded in cultivating a modified virus; with this thousands of sheep and oxen have been inoculated in Europe, and Pasteur was challenged to make a public and crucial experiment to demonstrate its capabilities. He says: "Fifty sheep were placed at my disposition, of which twenty-five were vaccinated. A fortnight afterward the fifty sheep were all vaccinated with the most virulent anthracoid microbe—splenic-fever virus—and the twenty-five vaccinated sheep resisted the infection; the twenty-five unvaccinated died of splenic fever within fifty hours."

This was the climax of the labors, through thirty-one years, of a series of men whose names would form a rosary of the illustrious biologists of the world, and whose discoveries meas-

ure a large arc on the great circle of our knowledge of communicable diseases.

The Present State of our Knowledge of these Germs.—In 1864 Dr. Lionel S. Beale called attention to the existence in vaccine matter of certain minute particles, transparent and of spheroidal form. These he regarded as living or germinal matter, and advanced the theory that they might contain the contagious principle. Soon after, Chaveau, of Lyons, France, carried the investigation further, and conclusively proved that the activity of the vaccine matter resides *exclusively* in these particles (seeds).

In 1874 Dr. Budd, in England, plaintively laments that man, after having triumphed over the most Titanic forces of nature, should himself be left the seemingly helpless prey of these unseen microscopical organisms—these fungi, micrococci, bacilli, spores, bacteria, germs, or seeds, or whatever other learned or common name we may choose to call them by: 1884 finds many investigations in progress, and many observations already made and recorded, by the best-equipped scientists of the world, a few points clearly settled, but the whole inquiry full of hope for practical benefit to mankind—a decade means a new world to the army of trained microscopists, when once started on the right track.

One of the settled points is that *temperature* has much to do with their development or destruction, and another is that while some lose their vitality soon if deprived of oxygen, this gas is directly fatal to others. The well-known action of frost in yellow fever is a case in point, and Mr. Tyndall has clearly demonstrated the vital necessity of oxygen to some germs. His experiments on *the floating matter of the air*, multiplied to the using of more than 10,000 experimental tubes, which were subjected to the most severe methods of sterilization possible to be devised (this to isolate the germ under consideration from any and all others), and submitted to the searching light of the condensed electric beam, and the scrutiny of the best microscopes that human art has yet devised, are a demonstration, not only of the germ-theory itself, but incidentally he

clears up many of the mysteries connected with the communication of contagions that have hitherto seemed unfathomable. He has shown that the air is full of germs, by no means all of them capable of producing disease in the human body, but that they will certainly spring into life if once they come in contact with the substance that forms their soil. Leave a pot of flour-

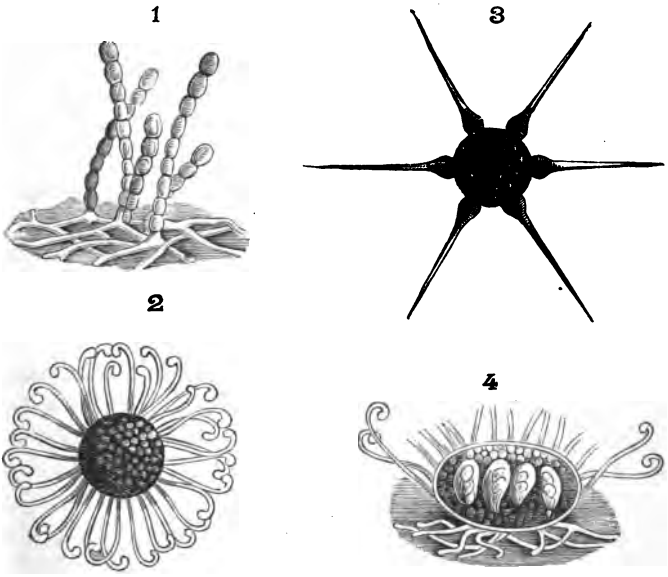


FIG. 37.—Molds and mycelium: 1. Mycelium that grows on grass and looks like hoar-frost, but under the microscope is a forest of minute plants. 2. Mold of the lilac-bush. 3. Another form of mold. 4. Vertical section of lilac-mold seeds or spore-sacs.

paste open, it is soon covered with a greenish-blue mold; an old boot left in a damp place is soon covered with blue mold, and a lilac-leaf in July will have spots that look like dust from the road. All of these are plants produced from air-sown invisible seeds, and under the microscope each one proves itself a perfect plant, in which the ripening of the seeds can be

watched just as perfectly as the successive ripening of the sweet-peas in a lady's garden. Here we have in the flour a "manufactured" vegetable product, in the boot a dead and "manufactured" animal product, and in the lilac a living plant. All these parasites, which derive their sustenance from the substances on which they are found, differ in form—they are as dissimilar as a lilac-bush, an elm-tree, and a nasturtium-vine; in fact, there seems to be a special microscopical destroyer for each different substance. Of course, these germs are perpetually coming in contact with all known substances, but only when the predestined ones are brought together is there growth and development. The difficulty of finding any fluid free from them will at once be manifest, and the corresponding difficulty of demonstrating that any particular germ has been the cause of transforming the structure of any particular fluid. But through boundless perseverance and ingenuity it has been done. Tyndall has succeeded in sterilizing experimental tubes; he has kept them under glasses from which all organic matter has been burned out by incandescent electric wires, and he has conclusively shown that perfectly sterilized infusions, perfectly protected from invasion by germs by being in perfectly moteless air, will remain free from all forms of microscopical life indefinitely. He showed that these invisible germs are as different in their behavior as the seeds that we plant in our gardens—that while some perish without oxygen, an atmosphere of condensed oxygen was fatal to others; that the vitality of many could be destroyed by five minutes' boiling, and that for others it required eight hours.

The more closely the various phenomena exhibited by germs are reasoned from on the assumption that they are true seeds, the more amenable are they to explanation. Seeds become desiccated and hardened so that they will refuse to germinate unless previously soaked. Some require soaking in boiling water; and the wool-staplers of Elbeuf, France, found that the seeds of the *Medicago*, that had been brought from South America in the fleeces, germinated after having been boiled four hours. Is it any wonder that the seeds of yellow fever

and cholera can and do spring into life after long periods of dormancy?

Dr. Hildebrand relates how he unwittingly spread abroad an epidemic of scarlatina in Podolia—a province in which it had hitherto been unknown—by exhuming and wearing a black coat that he had not had on for a year and a half, but which he had last previously worn when attending a scarlatina case in Vienna. In extenuation, it must be explained that this was previous to the modern knowledge of the way in which the disease is diffused.

We begin to perceive why the means of disinfection used in one malady are wholly futile in another—that each behaves "after his kind," and we begin to comprehend the observation of physicians that the character of a given epidemic is modified, as people have taken the poison in one way or another. *The state of preparedness* of the contagium, when it enters the body, undoubtedly has an important bearing on the time required for its development.

The period of "latency" or incubation, in typhoid, has been found to be less than a week, when its virus was imbibed in drinking-water—where we can imagine the germs already moistened; and it has extended to twenty-one days, where the poison has reached the system through the atmosphere.

The common garden pea can be soaked and "sprouted," so that in well-prepared soil it will show itself above the ground in three days, while the same peas planted dry would have required from ten days to two weeks. The seed of the cypress-vine requires boiling water to soften its tenacious black shell; then, after soaking twenty-four hours, two tiny green points can be discerned in its midst. If sown on a hot day, thirty-six hours will suffice for it to send down a root an inch long, and to send up its first four oddly-shaped leaves: had we placed it in the earth dry, we should never have seen it grow, and we might have falsely inferred, "*ergo*, there are no seeds." Also note the difference between the sprouted peas and the original dried ones, between the cypress seed in its impervious coat-of-mail, and the same seed when the future cotyledons are thrusting

out their soft, green points. Hot water, or that even moderately warm, would speedily be fatal to the tender, nascent vines. Mr. Tyndall calls attention to the great errors that have arisen from not discriminating between the dry, unchanged germs and the partially developed organisms. It has an important bearing on the true method of disinfecting. This should be done while the germs are in the "plastic" or easily destructible stage; and probably this explains why disinfection is most efficient "on the spot"; that is, everything should be disinfected before it leaves the sick-room.

A notion of the infinitesimal quantity of matter necessary to produce infection may be formed from the fact that the tip of a thread of the finest-spun glass, dipped in an infectious fluid, and then touched to the surface of a perfectly sterilized culture-tube, kindled it into activity, so that in twelve hours it was swarming with life!

Small-pox and Vaccination.—No one now doubts that small-pox is produced by the introduction into the body of a germ —the product of the disease in a previous case.

In its unmodified form, it has proved one of the most destructive pests that has ever scourged mankind. Previous to the discovery of vaccination, it had continued to destroy from one tenth to one fourteenth of all that were born. It left multitudes blind and deaf, and so universal was the disfigurement from it, that "a smooth-faced man" was noted and spoken of as just as much a rarity as a pock-marked one is to-day.

People born into the different state of things brought about by the beneficent practice of vaccination can form no idea of the diminution of human misery caused by this one application of the principle of warding off a malignant disease by destroying the susceptibility to it, through the production of a milder, related disease, that is known to exert a protective influence.

In depicting the miseries of those days, Macaulay says, "Small-pox was always present, filling the church-yards with corpses, and leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which its mother shuddered, and making the eyes and cheeks

of the maiden objects of horror." The private letters of the women of the time have frequent accounts of this or that high-born lady who had lost her beauty through the "pox." Think of it! Some

> "Daughter of the gods, divinely tall
> And most divinely fair,"

blighted into a repulsive object by a six-weeks' illness; and all this deformity and consequent unhappiness we now know might have been avoided. No wonder that the Lady Mary Wortley Montagu, seeing in Constantinople a practice of inoculation for small-pox, which saved a person from the general eruption, caused her son to submit to it, and hastened to proclaim its merits on her return to London in 1721, and had her daughter inoculated as a testimony of the faith that was in her. She exerted herself to enlist the sympathies of right-minded men and women and persons of influence, and largely through her zeal it became established, with a vast saving of life; but it remained for Jenner, in 1798, to announce the results of his systematic investigation of vaccination—the artificial production of cow-pox, as a protection against its formidable congener. He fought its battle against ignorance and prejudice, and fully demonstrated its merits. It had one drawback, as originally practiced. After it was once produced, the infective matter was taken from the arm of one person and used in another, with the occasional transmission of some constitutional blood-taint from which the first was suffering; but all danger of this happening is now removed by the use of "matter" produced in perfectly healthy calves. So thoroughly has this been systematized into a business that perfectly pure material can now be bought, prepared in the best manner for immediate use, at ten cents a "point," and sent to any distance through the mails. As the constitutional disturbance from this process is at its minimum when this is done in infancy, every faithful mother will see to it that her child is vaccinated before it is six months old.

The disease is just as virulent to-day as ever, if left to itself.

In 1882 there was an epidemic among the unvaccinated negroes of Cape Town, Africa; of 9,000 attacked, 2,400 died. The sources of infection are sometimes little dreamed of. A London doctor found a whole family in Bethnal Green suffering from small-pox, but those not yet too ill were working on beautiful white chenille, to be sold at the West End; and a man who knew that he had it, refused to stay away from a regatta at Lake Quinsigamond in Worcester, Massachusetts!

How to vaccinate.—A competent physician should always be employed when possible, but there are people who are beyond such aid, and for their benefit is here given the clear directions prepared for dissemination by the Michigan Board of Health. The vaccinator is supposed to be supplied with an ivory "point" of bovine vaccine matter, which can be sent by mail from the men who produce it on farms devoted to the business. Dr. Henry A. Martin, of 27 Dudley Street, Boston, Massachusetts, propagates virus from the celebrated stock of Beaugency, France; and Dr. E. L. Griffin, of Fond du Lac, Wisconsin, propagates from the government vaccine establishment of Brussels. From either place the vaccine matter is pure, and it is warranted to be efficient if used within ten days of its receipt per mail.

"The most convenient place to operate upon is generally the outer surface of the left arm, near the shoulder. An infant which its mother carries on her right arm should be vaccinated on its right arm, in order to avoid rupturing the vesicle by pressure against its mother. With a sharp-pointed and perfectly clean instrument (lancet) make six parallel scratches, barely sufficient to make a show of blood, but not to cause bleeding. Directly across these scratches make five or six similar scratches, so that the scarified place shall be as large as a split pea, and something like this illustration. If blood flows, wait and wipe it off before applying the vaccine lymph. The virus is at and near the pointed end of the carrier. Moisten the material upon the ivory point with half a drop of pure, cool water smeared over it with the lancet. *Then rub the point over the scarified surface briskly for*

FIG. 38.

a minute, so as to lodge the granules in the abraded surface. When the arm is dry, return its ordinary clothing, between which and the arm a loose, soft cloth may be fastened. Use no bandage or plaster. Let no saliva touch the spot. *Burn the ivory point* after using it for one person only. Do not scratch the vesicle produced, which will dry up, the crust falling off about the twenty-first day, and which, if efficient, will leave a permanent, well-marked scar."

Revaccination.—The protective power of vaccination after a time becomes exhausted, and through its neglect the most disagreeable consequences may follow. A little more than fifty years ago, before the day of railroads had so increased intercommunication as to make it difficult to trace specific instances of infection, a gentleman living in one of the interior towns of Massachusetts was called by business to New York. On his return he found himself ailing; he had nausea, chills, and considerable fever, all of which soon passed away, but, in a fortnight after the day of his arrival at home, his infant son showed symptoms of severe indisposition, which finally developed into the severest type of confluent small-pox, which left the poor child terribly disfigured for life. Subsequent investigation proved that the child must have taken the disease from his father, who, though successfully vaccinated in childhood, had contracted the malady in New York, where a widely diffused epidemic of small-pox was then raging. He had passed through a modified form of the disease that only amounted to *malaise.*

In the Bavarian army, where revaccination is compulsory, not a case of unmodified small-pox occurred in a period of thirteen years; and during forty-two years of duty, Dr. Marson, physician of the London Small-pox Hospital, has never observed a single case of small-pox in the officers and employés of the hospital, who are revaccinated when they enter the service, and who are constantly exposed to the infection.

By the great facilities for intercommunication, and the ease of transmission of packages both by mail and express, there is a menace of danger in every community. One of the com-

monest experiences is, that operatives in paper-mills, who handle rags brought from infected sources, are frequently attacked by the disease, and thus a local epidemic is kindled. Isolation of the sick and vaccination of the well soon "stamp it out," leaving here and there a poor, disfigured victim to deplore his ignorance of the importance of revaccination. Fortunately, the most progressive mill-owners are practicing the wisdom of shutting the stable-door before the horse is stolen, by having their employés vaccinated when they enter the mill, recording the date, and revaccinating in five years.

A vast amount of hygienic light has yet to be diffused before cases of small-pox will cease to be concealed by ignorant people, through fear of being conveyed to the pest-house by health authorities; but even where this has occurred the help lies in vaccination.

On March 13, 1859, Dr. E. M. Snow, of Providence, Rhode Island, found in a cluster of seven houses twenty-five families, and in these families ten cases of small-pox, all apparently at about the same stage of the disease. In the same families were twenty-one children who had never been vaccinated. The ten cases and the remaining members of the families, including the twenty-one children, were quarantined at home, and the children were all vaccinated and compelled to remain with the sick. Several other cases of small-pox occurred in persons previously exposed, but not one of the twenty-one children referred to had the slightest touch of the disease.

Where a community finds itself invaded by this disease, a hospital-tent has been invented, and can easily be put together and used, to supplant the old-fashioned pest-house. Patients can be made perfectly comfortable in them, and when well, the tent being burned, there is no seed or germ left to "carry over" the disease to a new set of persons. Even though a person may know that he has been exposed to the contagium of small-pox, he should be instantly vaccinated, although, if the "incubation" has progressed too far, it may be unavailing. Dr. Marson lays down the following: "Suppose an unvaccinated person to inhale the germ of a variola (small-pox) on

a Monday; if he be vaccinated as late as the following Wednesday the vaccination will be in time to prevent small-pox being developed; if it be put off until Thursday the small-pox will appear, but will be modified; if the vaccination be delayed till Friday, it will be of no use." Remember, these are the words of a man who has spent his life in the midst of the disease. Here is a table that speaks for itself, taken from Dr. Waterhouse's papers, with Dr. O. W. Holmes's comments:

Natural Small-pox—a contagious Disease.	Inoculated Small-pox—contagious.	Kine-pock—non-contagious.
One in six who take it dies. It is like an attempt to cross a dangerous stream by swimming, where one in six perishes!	One in three hundred dies. It is like crossing the stream in an old leaky boat, where one in three hundred perishes.	Never fatal. It is like crossing the stream on a new and safe bridge.

Notwithstanding the clear demonstration of the value of vaccination, a party opposed to it has sprung up in England. They point to the fact that blood-poison has been conveyed by it from one person to another, and an attempt to procure parliamentary interference was made. Sir Lyon Playfair admitted that it had been mischievous in four out of 17,000,000 of cases, and said: "The returns showed that while the rate of mortality from small-pox was 3,000 per million in the last century, the voluntary vaccination in force during the first forty years of this century reduced it to 600; the state-aided vaccination which followed brought it down to 305; while under the present compulsory system it is only 156." Hardly less striking is Sir Charles Dilke's remark to the effect that 960 men out of 1,000 are now, it is computed, vaccinated, and that out of the forty unvaccinated nearly as many die as out of the 960 vaccinated, in some cases more. When brought to a vote only sixteen were for returning to mediæval darkness, while 270 were still in favor of compulsory vaccination.

Since Pasteur has successfully applied the same principle to suppressing two formidable diseases among animals, and all the foremost physicists of the world are investigating these prolific disease-germs to learn their habits and how to destroy them, it is no wonder that in his enthusiasm he says, "I believe it is in the power of man to cause contagious diseases to disappear from the face of the earth."

The full acceptance of the germ-theory of contagious disease shows exactly where to combat it. Destroy the seed, you prevent the crop, and where this is impossible the next best thing to do, is to neutralize the conditions that promote their growth to the utmost.

CHAPTER VIII.

OVERLOOKED CHANNELS OF INFECTION.

Unsuspected Ways in which Typhoid-Fever Germs enter our Homes, and how to combat them.—This part of the subject of typhoid fever has been delayed till after the discussion of the germ-theory itself, so that the exact way in which the infection is spread from its unseen sources, and penetrates where it is least looked for, may be understood. The daily papers during the summer and fall have repeated accounts of outbreaks of typhoid fever, which are directly traced to contaminated wells, and the reports gathered by the various boards of health have now accumulated the incontestable testimony in so many cases, that the record alone would fill a bulky volume; and where one outbreak is sufficiently pronounced to create a sensation, such as leads to investigation by thoroughly competent men, there are undoubtedly many added thousands of solitary "cases" that never reach the eye of the public. Intelligent summer boarders are learning that "gastronomic delicacies, beautiful scenery, and the most comfortably furnished rooms," are all secondary in importance to the relative situation and distance apart of the well or spring that is to supply drinking-water and the cesspool or vault. But it is to be deplored that thousands of women, who would resent the insinuation that they are not "cultivated," take up their residence in places where they propose to while away the summer's leisure, without a thought of this vital matter; and then it needs watching the whole long dry season through. During the summer of 1883 a party of people took quarters at a modest but most comfortable hotel among the White Mountains. One of the

young ladies had been a great sufferer from sanitary neglects in other places, and her mother could not rest till the young woman had sent her a thorough account of the premises. All was as perfect as need be. A new pipe had been laid from a fresh spring far from the house, to insure pure drinking-water, and all went well till the first week in September. Then one after another of the two hundred guests of the hotel fell ill of unquestionable typhoid fever; of course, all who could, hastened away, but not till thirty-three had been attacked, and three had died. As the new spring had been secured "for good reasons," as the sequel shows, it was much vaunted, but unluckily it had not been tested through a season of abnormal drought, such as the last proved to be, in that region, and it wholly failed in the last part of August, and, unknown to the guests, the drinking-water had been drawn from the abandoned well; and so, where there are two sources of supply, a new and an old, it behooves the vigilant boarder to see that no indifference of employers, or ignorance and laziness of servants, results in his being served with the impure article. Note also that a patient may not be so ill that his complaint is recognized as typhoid fever, still may infect fatally waters that, entering the systems of people peculiarly susceptible, or any way debilitated, may cause death. In the Caterham and Redkill outbreak, where during six weeks three hundred and fifty-two persons were attacked, and twenty-one died, the man who had formed the center of contagion was able to do the work of loading the fragments of chalk, as they were chipped off into the buckets, and sending them up to the mouth of the shaft. He recovered and testified to the facts of the case, while twenty-one died. In this case the milder disease was analogous to the varioloid that did not confine the father to the house, but produced the most virulent type of confluent small-pox in the wholly "unprotected" system of the infant son. The thought here naturally suggests itself that in every community there may be persons who have had typhoid in a light and modified form, having contracted it from a virus modified in some way at present not understood, but which the researches of the present

time may reveal to us, and thus, though exposed anew, they escape. It is simply astonishing with what blind confidence people, who are alert and careful enough as to the appointments of their houses, will domiciliate themselves for months in a sea-side or other summer hotel where every appointment is of the cheapest and shiftiest kind.

The plates that follow may be said to be typical summer hotels, such as people have calmly and unquestioningly occupied, till now the constant agitation of the matter is bringing about a better state of things; but, as good plumbing is always costly, the sanitation will bear watching. The vital parts of these plates are exact reproductions of the sanitary arrangements actually found by a civil engineer of eminence less than two years ago, at a fashionable resort, and in the buildings themselves we see the familiar lineaments of hundreds of typical boarding-houses and hotels.

Plate No. 1 shows the back of an hotel accommodating one hundred and twenty-five people; two lines of soil-pipe and a bath-room waste and house leader (all on the outside of the house), which deliver into a vitrified pipe, laid on the surface of the ground. This pipe runs parallel with and close to the side-wall of the building, and in the foreground of the picture is just under the plank at the right. The kitchen, at the left, connects with vitrified drain by a lead pipe near the kitchen steps. This pipe is perhaps two or three inches underground. It is not unusual for market-wagons to drive between the two buildings, and the vitrified pipe has been more than once broken at the joints by contact with the wheels of a vehicle.

Plate No. 2 represents the same general arrangement, except that the drain-pipe is supported on a plank, and the ground-water (within eighteen inches of surface) has not been drained off. The main drain consists not of vitrified pipe alone, but of vitrified, cement, and iron pipes, patched together in an inexcusable way. This pipe has also been broken a number of times by teams striking it.

There is no need of dwelling on what has now come to be a familiar annual experience of the persons who return to

town, to be "taken down" with typhoid, but, if there are not *perfect* barriers between the city sewers and every house, any one can see how cases may occur in families who certainly have had no other exposure. "Impossible!" exclaims the disbeliever

FIG. 39.—Summer hotel. No. 1. ("Sanitary Engineer.")

—the man who says he "is sick to death of all this germ-nonsense, etc., etc." But here is what happened in Brooklyn a very short time ago: A doctor was called to a child, whom he

found to be suffering from scarlatina. He had a room on the third floor prepared for the reception of his patient, and he gave minute and explicit directions as to the disinfection of everything, especially the closet, which was of an antique and

FIG. 40.—Summer hotel. No. 2. ("Sanitary Engineer.")

objectionable pattern, and, in pursuance of his directions, it was daily douched with copious libations of carbolic acid. Soon after, he was called to visit a patient in another house on

the same street, and as the servant opened the door his nostrils were saluted with the strong and unmistakable odor of carbolic acid. Being an experienced sanitarian, he had a keen nose for "smells," and he could not let this pass unchallenged. He found that the smell dated from the day of the attack of scarlatina, that none of the acid had been used in the invaded house, and also that at intervals during each day there were times when the odor was comparatively overpowering. Of course, so interesting a suspicion must be traced. Not any of the intervening or neighboring houses had been troubled, and an examination of the plumbing of this showed a sufficient reason why, and led to instant and thorough reform.

We are apt to think of the sewers of a great city as a system of internally smooth walls, that are constantly washed out, but any tyro who has aided in their repair will tell us that those laid before the dawn of sanitation are full of defects, that they often have projecting shoulders of pipe that dam up their contents, and there are thousands of houses that to-day have no efficient water-seal between their living-rooms and this reservoir of the "pestilence that walketh in darkness." If these things make us creep and crawl, and feel that "it is dangerous to be alive any way," there is the compensating consolation that if sanitary science has established any truth, it has the certainty that disease-germs can not pass a constantly maintained water-seal.

Again, the annals of typhoid in health-reports bring out a striking uniformity in the way in which it follows seasons of exceptional drought, when, of course, there is a general lowering of the surface of the underground water. There is every reason to suppose that this water in towns and villages must have myriads of germs in it that have filtered down from the cess-pools and leaky vaults which, till recently, were thought adequate. Imprisoned in the water, they are harmless—peas at the bottom of a pan of water will sprout and decay—but the recession of the water leaves the germs entangled in the interstices of the earth, just as a porcelain filter lets through a liquid and retains its residuum. Now, oxygen can reach them; this is the grand factor needed for their growth; it finds them in a state

of complete preparedness, and it is not strange that epidemics are attributed solely to the change in the level of the water-table, notwithstanding the growing belief in the "drinking-water theory."

Typhoid-Fever Germs in Milk.—Do cows have typhoid fever? Science has not so discovered up to date; then why the above heading to a paragraph? Because there have now been several typhoid epidemics in England and America (at this moment one in Port Jervis, New York, is being investigated) that

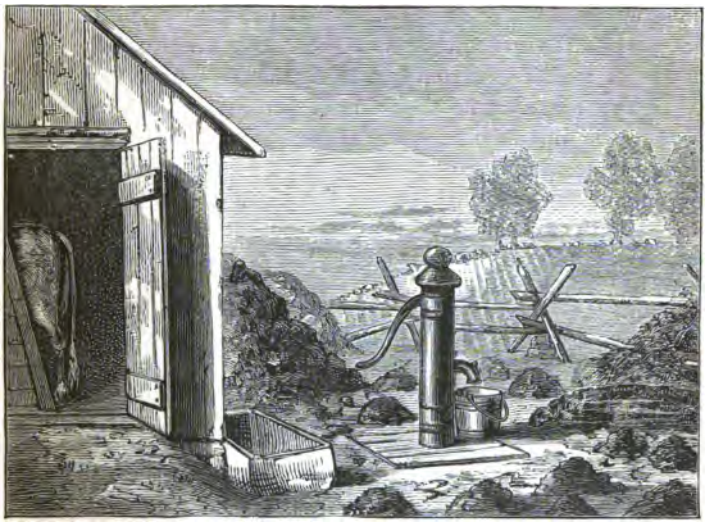


FIG. 41.—Milk-Farm near New York. ("Sanitary Engineer.")

have been directly traced to the use of milk from dairies where either among the owners or employés were persons suffering from typhoid. In St. Pancras, in London, it was proved that, of four hundred persons attacked, three hundred and sixty-eight had their milk from the same source. The farm was examined, and several employés were found to have had the fever, and the fact that a sycamore-root penetrated between the well and cess-pool, was made the scape-goat by the owners, who con-

fessed that the pans and pails were washed in water from this sycamore-haunted well! The foregoing picture was made, not because that particular farm had been accused of furnishing contaminated milk, but because an artist strolling that way was struck with its hideousness, and here is his description of it: "The sketch is, as near as I could make it, a literal reproduction of the filthy scene. The pump at the center of the sketch was depended on for the drinking-water, and for washing the pans. Not ten feet from this pump was a sodden slough of animal refuse of all kinds; and there were manure-piles from thirty to fifty feet distance at a rough estimate, while the ground around the pump was liberally sprinkled with manure. From questions I asked and replies given, it was apparent that no suspicion of pollution of the water had crossed the minds of the persons who ran this milk farm, though it was impossible that every rain should not wash the contents of the slough right into the well."

A doctor was asked by the Massachusetts Board of Health, "Do you believe that milk can convey typhoid-fever germs?" "No, but I have no doubt that the water it is diluted with often does," to which a chorus of echoes, "That's the real desiccated truth," comes up, and the fact that every milk-infection case that has been traced to its source has ended at the bed of a person ill of it, however many sycamore-roots may have intervened, is proof enough for most minds.

Here the remedy is in the hands of the women, for, if all infected dairies were resolutely "boycotted" by vigilant mothers, the dollar-and-cent argument would soon reform the least conscientious dairyman who ever saw pulverized chalk. He would come to understand that "watering" has unexpected ways of self-revelation.

How shall Disease-Germs be kept out of the Drinking-Water of small, compact Villages?—By the intelligent co-operative action of *all* the men and women of the village; and in many of the older parts of the country it will not be strange if the women have to initiate and organize the necessary reforms. A moment's reflection will show us that in villages that have been

long lived in, where cess-pools have been made designedly pervious, and where vaults have been constructed with no thought of making them water-tight, the ground itself is infected, as Dr. Budd says; and where cess-pools and wells succeed each other in each house-lot, the danger need not be enlarged upon. It is a delightful consequence of the quickened thought of the day in the direction of *prevention*, that our social science associations are discussing "*the best ways of obtaining pure water-supply in small towns and villages*"; and the striking diminution of the death-rate that has followed the introduction of "pipe"-water in many places, will stimulate enterprising communities, who can possibly compass it, to at once apply the heroic and comprehensive remedy of a system of water-works. Were a money value placed on the life of every able-bodied man and woman lost by typhoid fever and other diseases from bad wells, a short sum in arithmetic would demonstrate the "economy," in a money point of view, of even the large outlay demanded by this; but, after all, there will still remain many hamlets and villages where the well and the vault must be the reliance. Where the wells are made as described at page 73, and especially where they are carried down below a dense stratum, which acts as a barrier between soil infiltrations and the pure water below, it is a great advance on the ancient, loosely built earth-colander. It is no formidable engineering task to construct of stone, cement, and asphalt, perfectly impervious vaults, with surfaces that will resist the action of those disinfectants that should be periodically used. Again ceramics come to the front, for already there is a vault made of a single piece of terra-cotta earthenware, glazed by a stanniferous process, making it proof against carbolic acid, copperas, etc. An efficient apparatus, called the "Odorless Excavating Apparatus," cleanses them without offense to sight or smell. It is already in use in many places.

The only thing lacking in this chain of "means to an end" is that "eternal vigilance" that can not be invented, manufactured, or patented. Perhaps the legislators of the future will discover that a man has no more right to poison his neigh-

bor's air than he has to put arsenic in his bread or well, and then we may get a definition of "nuisance" that will reach to depths and breadths at present not dreamed of; but, till that time arrives, we must depend upon voluntary effort.

Here we find a large and useful function for those rural sanitary associations that are springing up all over the land. One of these in its corporate capacity can easily own an apparatus originally costing six hundred dollars, and also secure systematic inspection and care of premises, with no anxiety on the part of the owner, save to pay his assessments. In the town of Bridgewater, Massachusetts, a household inspection was conducted under the authority of the Town Board of Health. It cost twenty-one cents per dwelling. The Sanitary Association can easily employ a competent person to inspect, to disinfect, and to cleanse, one thing only being a *sine qua non*—ALL must unite in the scheme, otherwise one focus of infection may neutralize the efforts of the entire remainder of the community; but when every woman is as earnest in demanding pure air as she is to have "good clothes" and a parlor carpet, we shall at once see a great diminution in the numbers of that army of "miserables," who are suffering from insidious blood-poisoning that doesn't kill outright, but destroys enjoyment of life. Does any one say, "It will cost money." True, but what good thing worth the having does not cost money, time, or care?

Typhus Fever—Jail-Fever—Spotted Fever.—What judge in these days looks forward to an attack of this malignant disease as a likely incident in holding a criminal term, and what juryman feels that being "drawn" is equivalent to a death-warrant, if a prisoner is to be brought before him? Not one, while a hundred years ago, in England, this was one of the commonest of occurrences; and the more humane treatment of criminals, which has given them more light and air, has aided in demonstrating the value of *enough air* for each human being, if he is to have a fair chance for health and life. It would seem that some peculiarly malignant germ finds its congenial soil in the effete residuum from the human breath—as epidemics of this disease radiate invariably from some *over-*

crowded cheap lodging-house or public institution, where cubic space is reduced to the minimum. No disease more perfectly marks modern progress than this, which has ceased to be a terror since its cause has been understood, but its effects ought to warn parents to insist on spacious, airy school-rooms for their children.

The mediæval plague seems to be a near relation of this disease, but that often attacked populations whose vitality was reduced by insufficient food and the worst imaginable sanitary conditions. A bad harvest in those times meant an actual deficit in food to simply sustain life, such as can not occur in these days of increased communication in the remotest province, and it uniformly followed famine as a predisposing cause, and war as the sower of its specific germ or seed.

Consumption: How to guard against its Infectiousness.—The folly of sleeping with a known consumptive need not be dwelt upon; and many ways of guarding the well will suggest themselves. If it shall eventually be proved that this disease is communicated by a germ—the *bacillus tuberculosis*—expectorated in the sputa and given off in the nasal discharges of a patient, and which does not lose its vitality by drying or by time, we shall do well to take a lesson from the Japanese in personal habits. They think our habit of using a handkerchief and returning it to the pocket unspeakably filthy—they use pocket-handkerchief paper and throw it away; but when our sanitary consciences are educated up to the full measure of the law of brotherly love, we shall use paper, *and burn it*, with its death-bearing seed: there is a great future before fire as a purifier in other fields than cremation. So universal is the dissemination of this morbid material, that we may marvel that any one has escaped the infection. A series of very interesting experiments has lately been made in inoculating animals with matter that produces a bacterial disease in the bones. It is found to have no effect unless there is some abrasion in the covering of the bones—while that remains intact, no disease is developed; but the tiniest aperture lets in the destructive enemy—just as a mouse can burrow through the dikes of Hol-

land and work infinite mischief; so there is a state of preparedness in the tissues as well as the seed, in the soil as well as the germ. An irritated throat may yield to diphtheria, while a sound one can resist its onset.

Fever and Ague—Chills and Fever—Malarial Fever—Malaria.—A disease as old as history, and distributed in spots over nearly all the habitable globe: in the torrid zone often a swift death, and in the temperate undermining the most robust constitutions, it has remained for the last decade to fully reveal the organism that causes it—the *Bacillus malariæ*. It would be but small consolation to the quaking victim of ague, with his teeth chattering and his blood seemingly turned to liquid ice, to tell him that the source of all his woes is a shining oval spore, $\frac{1}{6000}$ of an inch long, that comes out of certain kinds of moist earth, and, gaining access to the inside of his veins, there multiplies into millions, causing him boundless suffering meantime, if it could not be also demonstrated that there is a predestined and efficient parasiticide that can destroy the destroyer; and, better still, that by studying its haunts and habits he can learn how to fortify himself against the formidable onset of this vicious infinitesimal. A series of careful observations and analyses, made by Klebs and Tommasi-Crudeli, Marchifava, and Carboni, and later elaborate experiments by Professor Ceri, have discovered in the soil of malarial districts a shining oval micro-organism which they were able to reproduce in the animal body, and also in "culture"-experiments. Animals infected with them exhibited not only the clinical course of malarial disease as seen in man, but also the *post-mortem* appearances; while the bacillus was found in the blood of the affected animals after death. The spores develop in the animal body, as well as in culture-experiments, into long threads, which at first are homogeneous, but later divide, while new spores develop in the interior of the segments. This germ was found to die unless it had free access to air. The fungus was developed in the fresh serum of rabbits, and injection with this serum produced the same fever. All the rabbits when killed had enlargement of the spleen, which contained a

dark-brown pigment. The spleen and lymphatics contained small bright corpuscles which developed, after twenty-four hours in a suitable medium, into threads filled with spores.

Finally, Dr. Franz Ziehl had the opportunity to test these results clinically, as he had under his care three typical cases of malaria, in all of which *the* feature of the disease—enlarged spleen—was present. In all of these the bacilli above described were found in the blood, taken from any part of the body by the prick of a needle, while he could not discover them in the blood of healthy persons or of those suffering from other diseases. In two of these cases *the use of quinine was followed by prompt relief, and the disappearance of the bacilli from the blood in seven and nine days respectively;* the third improved under the use of Fowler's solution, but, unfortunately, the opportunity to examine the blood was lost. These spores are abundant in certain places where vegetable decomposition has been carried on for a long time, in alluvial soil away from light and air, especially in such soils overlaid by water and then suddenly exposed to the action of the atmosphere. In some marshy regions which are subjected to alternate wetting and drying, and in many cases where salt and fresh water meet, it is especially malignant—the common names "marsh-miasm," "coast-fever," and "river-fever," testify to this. The breaking up of some soil for railway excavations (in Schaghticoke it made a whole population sick), digging foundations for houses and deep drains, and for agricultural purposes, where the ground has long lain untilled, seems, by bringing the germs in contact with air, to develop them enormously. The local epidemics of chills and fever, consequent on the "drawing down" of factory reservoirs, are familiar examples, and some of the most thoughtful observers attribute the reappearance of this disease, in some of the oldest parts of New England, to the general and ruinous deforesting that is going on, diminishing the volume of the streams, and thereby exposing a ribbon of alluvial mud full of ancient vegetable *débris* to the vivifying power of the sun.

Different kinds of spores have entirely different habits. Tyndall found one kind that came up out of the liquid on to

the side of the tube in search of oxygen ; a whiff of it killed others. We know that some plants only bloom at night ; e. g., the four-o'clocks and some species of gourds. Because a seed is infinitesimally small, is no reason why it should not have its own style of behavior ; it seems pretty certain *that those malaria-germs that cause fever and ague are held in suspension in the moist exhalations that rise from grounds which produce them.* Hence, when the midday sun renders the air dry and buoyant, a person can pass with impunity through a region that would be highly dangerous at nightfall, when the cooling of the earth has condensed the vapors to dew, and seems to bring the spores down to the average level of the human breathing apparatus in immense numbers. In the last century, before the extensive drainage-works undertaken by the Italian Government had partially dried them, it was known to be fatal to be caught out at night on the Pontine Marshes. The influence of even a small fire in a closed room in counteracting their attacks may depend on a slight but sufficient desiccation of the air thereby produced. In some of the malarial portions of the South, this method is used with good results. A very slight barrier will sometimes fend them off—a stone wall, a thicket of trees, a muslin curtain. In Italy, where they have the accumulated experience of thousands of years, they call the hours after sunset the "evil hours," and to sit by an open window at evening without a curtain would be thought a wanton exposure of health ; and it is of interest to note that Mr. Tyndall finds cotton fiber the most efficient means of keeping germs out of air that he wants to render scientifically pure. Here even a lady's gauze veil may have uses beyond what we have been accustomed to suspect. This miasm does not seem to rise very high perpendicularly ; hence people sleeping in the upper stories of houses have been known to be exempt, while every person who slept on the ground-floor was suffering from chills ; but it has been known to be borne horizontally across a broad lake when the wind changed, and to a ship anchored four miles from a malarious shore, so that every man had the fever ; and in the tropics it has seemed to be brought down

from the air by sudden showers that have prostrated entire regiments and whole villages. It is easy to see how it can be contracted even in a city, where deep excavations are often made for foundation-walls, and also why unfinished suburbs, where drainage is very incomplete, are generally so insalubrious.

Dr. George Derby, the first Secretary of the Massachusetts Board of Health, writes: "It may be regarded as an axiom of sanitary science that both air and water require incessant movement. Nature provides that these two great agencies for the maintenance of health shall be supplied in a condition of purity. Man corrupts them, and is in turn corrupted. Both deteriorate when their original condition of freedom is interfered with by human contrivances. We are not to expect in the midst of civilization, with all the complications which man's industry has woven about us, that water obstructions can be avoided. Hardly a town in our territory is without its dam and mill. Their benefits have been great and their evils infinitely small. Wherever a good water privilege exists there soon spring up various manufactures, requiring many laborers and the greatest economy of the power of the stream. The village becomes a factory-town, perhaps with a crowded foreign population; the dam is soon raised, and, instead of a free movement of the water, we find a great reservoir in which it is stored for seasons of drought. The character of the country above such obstructions may be thus greatly changed. If it happens to be flat and level, the inhabitants may find their meadows converted into swamps, their dry homesteads into damp and spongy and half-drowned lands, which will undermine the health of their occupants and kill them by slow degrees. This conversion of dry soil into one which is permanently wet may at the same time cause the gradual development of consumption in hundreds of families. The reservoir itself is a still more frequent cause of ill-health to the dwellers on its banks. In addition to soil-moisture, which it occasions, it is very sure to receive the wash and the waste of many people. The movement which is necessary to the work of purification being prevented, the result is seen in a pool whose rank vegetable growths indicate

the half-hidden impurities on which they are nourished. In the summer, the season of drought, when the mill-power is at its minimum and the fever-power at its maximum, the reservoir is often entirely emptied and the whole bottom exposed. It then becomes evident, from the faint and disgusting odor, what dangerous stuff has been fostered in the half-stagnant water."

The accumulated experience of Massachusetts, during the years in which her sanitary condition has been mapped and recorded, shows many instances in which the exposure of reservoirs has been followed by outbreaks of typhoid fever; and we now know that typhoid and the periodic fevers are very near relations, born of the same parents, so to speak, but reared and developed in different circumstances.

Supposing that we have an atmosphere laden with disease-germs, an agitating wind would help to disperse them; but the miasma, in being borne onward, may encounter such an obstacle in the conformation of the surface of the earth, that at certain points it accumulates in fatal proportions. The malaria itself is dammed up. Valleys nestled closely under high mountains, and villages sheltered by shelving hills, have been visited by epidemics of malarial disease which, in the present state of knowledge, can be accounted for on no other theory.

Far greater thought will no doubt be given in future to the placing of houses. It will not be enough that the fine corner lot looks attractive. The buyer will inquire, "Is there a focus of blood-poison within striking distance?"

In dealing with this enemy, the great point is like that in dealing with the lion's mouth, *to keep out of it;* and in protecting a household—1. Choose a site for the house as far removed as possible from a boggy marsh; if you live at the West, keep as far as possible from the "slough," known in the vernacular as "fever-and-ague holes." 2. Avoid sleeping on the ground-floor. 3. Close the lower windows at night, and in damp seasons make a little fire, enough to dry the air. 4. If any digging for drains or other purposes must be done, select that part of the year when the thermometer stands below 60°. If any

commanding necessity, like the repair of pipes that run through ague-bearing soil, demands the upheaval of this pernicious material, have it done in the middle of the day; let the digger protect his mouth and nose with a handkerchief, and cause the freshly turned earth to be *at once* sprinkled with quicklime. A large amount of cleansing of foul water-courses was achieved, in the height of summer, with evil consequences to no one, in Nashville, by taking these precautions when that plucky city was preparing itself for the expected invasion of yellow fever, under the guidance of an intelligent and thoroughly roused health board.

One of the most earnest and first members of the National Board of Health was rudely aroused from the idea that a roomy house in an apparently fine location, and in which there were no visible leaks and no perceptible odors, must be "all right," by a cruel experience which transformed him into an almost rabid sanitarian. Malaria did it, and in the following manner: Eight years previously he rented a house in a wide, sunny street, all the houses on which connected with a sewer quite a long distance off; at the backs of the houses, previously to the construction of this sewer, very inadequate cess-pools had been used, with the result that the soil thereabout was pretty thoroughly saturated. It became necessary to run a sewer across the seven house-premises which constitute this short cross-street—not at all for the accommodation of the dwellers thereon, but simply to make a connection between two other large branches. The work was done during a very hot, dry week in June or July, and it was only a short time before the earth was replaced, and everything seemed just as it was before a spade had struck into the ground. Events proved that a dark and potent spirit of evil had been released from its safe imprisonment, and was working its malign will upon a band of unoffending and most unsuspecting victims. August found, in each of those seven houses, cases of diphtheria, typhoid fever, fever and ague, or cerebro-spinal meningitis. Members of the families who had been absent during the excavation escaped, proving conclusively that the cause was *local*. Of the victims

some died, some recovered after a protracted siege of suffering, and one, at least, was left with such a weight of infirmity and disability that when, three years after, death put an end to her misery, every one, even her parents, said, "Thank God!"

Now that all these diseases have been demonstrated to be produced by "blood-poisoning," and are scientifically classed as *preventable*, it is no wonder that among the survivors should be found this splendidly aggressive enemy of malaria, who has borne his honorable share in the redemption of blighted Memphis, and whose pen and voice are sleeplessly active against the "pestilence that walketh in darkness"—i. e., hides itself in a mantle of invisibility.

Exactly what was this decimating influence which emanated from that freshly turned earth under the torrid July sun? Exactly how did it work such deadly mischief? The potent demon was—malaria; a "spirit of earth," which has wrought its cruel will among the children of men unchallenged for thousands of years; but in this progressive nineteenth century it finds itself confronted by an army of patiently peering scientists, who have "trained" a myriad of compound and double-compound lenses on it, and compelled it to give up its secret.

It is gratifying to record, now that the researches of the trained scientists of Europe—backed by the resources of governments, especially the Italian—have really demonstrated the style and dimensions of the *bacillus malariæ*, that an American (Dr. James H. Salisbury), more than twenty years ago, divined the true pathway along which the organism would be discovered. He published an article in 1866 on "The Cause of Malarious Fevers," in which he described micro-organisms that he had found in marsh exhalations collected on glass plates suspended above marshes at night, and also in the secretions of fever-and-ague patients. He also found that quinia arrested their growth. Evidently, here was the germ of a great truth. He believes that the various types of malarial disease are produced by the differing levelopment of different but allied species, and that the *bacillus malariæ* is a near relative of the organism that produces a congestive chill.

Malaria in City Houses.—To-day there are multitudes of people with pronounced chills and fever, who contracted them in the houses where they live, and other multitudes suffering from the group of symptoms known as "malaria," the difference being only one of degree, not of kind. It is true that no word has been more abused than this; none more frequently wrested from its legitimate meaning. Every medical man knows that, among the myriad diseases, there are many very puzzling symptoms, which, by the ablest diagnosis possible, are not readily referable to a distinct and definite cause; while every patient wants his disease ascribed to a distinct and definite cause. Many distressing ailments have so many obscure factors uniting in their causation, that it is not easy to say which is chief; and so, often to escape a closer questioning, a really discriminating and conscientious man says, "Perhaps you are suffering from malaria," while a less scrupulous practitioner boldly declares, "The root of all your trouble is malaria." It has been made to include rheumatism, neuralgias, dyspepsia, and has even been applied to that constant cough, that afternoon fever, the glowing hectic of the cheek—"that last flag of distress which Nature holds out when sinking in consumption"—which form an unmistakable *ensemble*.

Could the exact physical history of each of these be clearly traced, a large majority would prove to be the victims of that form of blood-poisoning which comes from sewer-gas, admitted to dwelling-houses either through incapacity on the part of the plumber who originally designed the "piping" of the house, or parsimony on the part of the owner, who refused to expend a sum that would compensate for thorough work, or deliberate and murderous "scamping" on the part of the contractor. Or, granting that the house was built in the best manner, according to the sanitary lights of its period, it has very likely acquired cracks and injuries, or the pipes may have rusted out; and a hole large enough to admit the finest sewing-needle is large enough to permit the escape of numbers of those disease-germs which measure but $\frac{1}{3000}$ part of an inch in diameter.

However careful the owner may have been in the erection

of his house, if it stands on "made land" he can never be certain that all parts will settle equally, and it takes but a trifle of inequality to twist open and pull apart even well-made joints.

There is no reasonable doubt that malarial germs which are cousins-german to those that emanate from a Western "slough" do make their way from city sewers through plumbing fixtures that were unintelligently planned in the first place, or imperfectly executed in the second place, or have become deteriorated by time in the third place.

Dr. Buchanan made an exhaustive study of an outbreak of typhoid fever, in 1875, in Croydon, England, in which one hundred and four persons died. He says: "I satisfied myself that in a very considerable majority of the Croydon houses that have had fever, drain-air, charged with infection from the common sewers of the town, has had the opportunity of entering the houses, and this sewer-air was, throughout 1875, charged to an intense degree with the infection of enteric (typhoid) fever. In some cases the sewer-gas escaped from the pipes with a noise, even when there was no smell."

In the most perfectly flushed sewers, of the city that has made them under the latest and fullest sanitary light, there must be, owing to the constant entrance of greasy and other adhesive material, more or less of particles that "stick"; anybody who has seen a city sewer under repair need not be told that there is this, and also more or less of fungi and mold; so that here, shut away from light and air, the same kind of fermentation goes on as that at the bottoms of reservoirs—that peculiar fermentation that fits it for the soil or habitat of the malarial germ. And these germs do not neglect their opportunities: the soil once ready, they take possession and increase and multiply, whether that soil be a sewer, or the blood of a person who sits perchance in calm unconsciousness in a gorgeous chamber above, but with a small continuation of the sewer extending untrapped up to his wash-bowl. If these conditions obtain in the newest and latest, what can be expected in the old "systems" in Eastern cities, where, when they were made, the engi-

neer's only thought was to form a continuous channel through which water was to be carried off?

In houses which lack perfect barriers to the entrance of disease-germs are thousands of people to-day suffering from malarial poisoning that had no other source; they are generally too sick to be well, and too well to go to bed: in set invalids' phrase, they are "miserable." The only defense against this invisible invasion is in *perfect plumbing*. In how many of what are called good houses does it exist? Probably in not one half of the houses built before the sanitary awakening.

In New York the tenement-houses that have been built under a well-enforced building law are, on an average, better plumbed than any equal number of even palatial houses built ten or more years ago. In London, where practical sanitation has taken a mighty hold on all classes, but especially the influential ones, an inspection of 362 houses showed 21 with their drains wholly choked up so that there was no communication whatever with the sewer, and 117 with leaky soil-pipes, while some had alternating pieces of lead and iron, and, as it is most difficult to make good joints between these two metals, leaks were plenty. This is the method of testing adopted: The drain-pipes are plugged at their outlet, and then filled with water and watched; a lowering of the level reveals the fact of leaks, and after this they are tested by oil of peppermint for gas-leaks; and Professor Fleeming Jenkin says that "the number of accidental injuries to pipes is great beyond belief. About six per cent of the houses have their drains choked, and over thirty per cent show leakage of sewer-gas through faulty pipes." In Boston over 35,000 defective drains and deficient pipes were overhauled for repairs, at the instance of the City Board of Health, during 1883. There, too, the experiment of inspecting several hundred houses, in different parts of the city, without reference to any previous knowledge or complaint of their condition, in order to test the average condition of dwellings, was tried: 491 were examined; there were defective drains in 279, and only 40 had ventilation to soil-pipe or drain. Any dispassionate observer will acknowledge that household

sanitation has at present a stronger grip there than it has yet gained in the proud metropolis, and it is not pleasant to dwell on the state of things that might be found in New York, if a disinterested expert were employed to examine any five hundred houses taken at random; and the case takes on a cumulative aspect when we consider that there is an added danger when pipes intended to be full of water are left empty for weeks in upper stories, and for many hours each day in those lower down, in large sections of the city. New York may take a useful hint from Boston in the interim that must pass before the completion of her new aqueduct. The inspectors of water-waste in Boston, by compelling the use of good fixtures, and other measures, diminished the daily waste 1,500,000 gallons.

"An inhabited house is a sort of gigantic cupping-glass, and the heat-rarefied atmosphere of the rooms is continually replenished from the air-stores of the soil"; and if that soil was naturally malarious, or has been saturated by ooze from broken drains, the people who do the inhabiting need not look further for the cause of their malaria. If anybody doubts the potency of sewer-gas, let this convince him: The health authorities ordered a school-sink in a tenement-house, 222 West Seventeenth Street, New York. While the work was being done, no disinfectants were used when the sewers were opened, and six children—occupants of the houses—watched the progress of the work; and within a week two of them died, and all the rest were severely sick with unquestionable blood-poisoning.

The Proper Method of Disinfection in Diphtheria, Scarlet Fever, Measles, etc.—As all these belong to the class of blood-poisons, and as all can be easily communicated, and as the method of disinfection that is efficient for one is so for all, we transcribe the rules prepared and distributed as a tract throughout the State of Michigan by the Board of Health:

1. Every person known to be sick with this disease should be promptly and effectually isolated from the public; one or two persons only should take the entire charge of the patient, and they should be restricted in their intercourse with other persons.

2. The room in which one sick with diphtheria is placed should previously be cleared of all needless clothing, carpets, drapery, and other materials likely to harbor the poison of the disease. This room should constantly receive a liberal supply of fresh air, without currents or draughts directly upon the patient. It will be well also to have the sun shine directly into the room.

3. The discharges from the throat, nose, and mouth are extremely liable to communicate the disease, and should be received on soft rags, which should immediately be burned.

4. The discharges from the kidneys and bowels are also dangerous. They should be passed into vessels kept thoroughly disinfected with nitrate of lead, chloride of zinc, or sulphate of iron (copperas), and then *buried*, at least one hundred feet distant from any well.

Copperas dissolved in as little hot water as will dissolve it is good.

5. Nurses and attendants should be required to keep their hands frequently disinfected, by washing, and using chlorinated soda.

6. Soiled bed and body linen should be at once placed in *boiling* water, or in water containing chlorinated soda, chlorinated lime, or solution of chloride of zinc.

8. The body of a person who has died of diphtheria should as early as practicable be placed in a coffin with disinfectants, and then tightly closed. Afterward the body should not be exposed to view except through glass.

Even this custom should be discouraged.

9. No public funeral should be held at a house in which there is a case of diphtheria, nor in which a death from diphtheria has recently occurred. No children, at least, and it would be better in most cases that few adults, should attend such a funeral.

10. The room in which there has been a case of diphtheria, whether fatal or not, should, with all its contents, be thoroughly disinfected by exposure for several hours to strong fumes of

chlorine gas, or of burning sulphur, and then, if possible, it should for several days be exposed to currents of fresh air.

To disinfect an ordinary room with chlorine gas: having tightly closed all the openings of the room, place in it an open earthen dish containing four ounces of peroxide of manganese. Pour on this one pound of strong muriatic acid, being careful not to breathe the fumes. When certain that continuous evolution of chlorine is taking place, leave the room and close the door.

To generate sulphurous-acid gas, put live coals on top of ashes in a metallic pan, and place on the coals sulphur in powder or fragments.

A convenient way is to place the coals and sulphur on a heated stove plate or cover turned bottom upward in a pan half filled with ashes. To disinfect one hundred cubic feet of air requires the thorough burning of about one and a half ounce of sulphur.

13. After a death or recovery from diphtheria, the clothing, bedding, carpets, mats, and other cloths which have been exposed to the contagium of the disease, should either be burned, exposed to superheated steam, to a degree of dry heat equal to 240° Fahr., or be thoroughly boiled.

Diphtheria.—We are apt to think of this as a modern disease, but Hippocrates, who lived 460 B. C., accurately described it; and three centuries ago tremendous epidemics of it swept through Spain, where they called it *garrotillo;* and in 1758 it raged in parts of England, under the name of *morbus strangulatorius*, when, if they could not cope with it intelligently, they could fit choking names to it which vividly indicate its chief point of attack. It carried off two thousand people in Basle in 1517. There is no doubt that it is a blood-poison; exactly how it is developed outside the human body is not known, but it has been proved in hundreds of instances that unsanitary conditions have the power to push it into malignant virulence; and it is highly contagious, the violence or malignancy of the contagium being in direct proportion to the severity of the case from which it emanates, though malignant

cases have occurred by exposure to a mild case. The contagium developed by the disease itself, and by which it spreads, is diffused by the breath, exhalations, etc., of the patient through the air immediately surrounding him, as well as by clothing, or other articles that have been brought in contact with the products of the disease.

Scarlatina.—The small, bran-like scales from the outer skin, that shed so freely, are one of the most efficient means of extending this disease, and they retain their vitality for years, so that sheets and underclothing should never be carried from the room dry, and when fully convalescent the patient should receive a warm bath in warm carbolized water, or carbolic soap should be used, and then the entire body should be anointed with vaseline or camphorated oil. Six or eight weeks should elapse after convalescence is established before the child is allowed to attend school. The sequels of scarlatina are so severe—deafness, suppurating glands, kidney-disease, etc.—that mothers should closely watch their children for at least the above period.

Teachers as well as parents should be on the alert to exclude this disease from schools, and a general knowledge of its nature will aid this good work; but there is no doubt that in our large cities children are allowed to go, after the parents know they have been exposed. But "more light, more light," will be the ultimate remedy here.

Yellow Fever.—In nothing is the beneficent power of the light of knowledge more clearly shown than the comparative calmness with which an impending invasion of the above disease is now regarded, and the terror which formerly pervaded panic-stricken communities at the bare possibility of its advent. Nobody now expects yellow fever to gain a serious foothold in the clean cities of the country, and if experience has demonstrated anything it has shown the power of filth to promote the activity of its poison: not that all dirty cities have it, but, as Benjamin Rush, that prophetic and sagacious man, said in 1779, "The suspension of sickness from filth no more proves it to be inoffensive than the temporary absence of

remorse for wicked actions proves them to be innocent." The splendid work done in Buenos Ayres—in which sixty thousand persons died of yellow fever in 1870—to reform its unsanitary state, is one of the grand *preventive* steps of the century. One person in every nine perished. Spurred to action by a mortality hitherto unmatched, works to secure thorough sanitation were undertaken, which, when completed, will cost $20,000,000.

The redemption of Memphis is another of the grand *preventive steps* of the century. The truly scientific but bold defiance to an epidemic as a whole, made by the city of Nashville, in 1878, strictly on Cromwell's "keep-your-powder-dry" principle—i. e., acting on accurate knowledge—is a shining example of what intelligent action can do. They cleansed their city: the sluggish streams were dredged out, every inch of exposed surface being coated with quicklime before nightfall, and every freshly bared rock was painted with coal-tar. The water of the foul streams was purified with barrels of quicklime.

Malarial spots in any city predispose their inhabitants to the disease, and this epidemic showed it anew. By isolation of the sick, *thorough* disinfection of their belongings, and keeping *things* likely to bring the seeds of the disease out of it, their city escaped an epidemic, while there were enough cases among men who handled freight from infected places, that came before the precautions had been enforced, to prove that the exemption came from no anti-yellow-fever quality in the normal elevation or air.

But the noblest step of all was the preparation, in a large building a mile from the corporation limits, of the Barrow Hill Infirmary, where it was proposed to take in and nurse any refugees from Memphis or other infected places. The active life of the city flowed on, undismayed by the terrible stories of death in other places—for the city had a *safety-valve*. To the poor creature fleeing from his home and seized with the ominous chill in the car, it was a beacon-light. Could he but reach it, he would have medical care and nursing of the best, supplied by the unrivaled hands of the Sisters of Charity. Here,

under the active supervision of Dr. J. D. Plunkett, who asked no remuneration, but was richly repaid by the grateful appreciation of his fellow-townsmen, for two months the beneficent work, which makes Nashville a light-house on one of the high headlands of progressive medicine, went on, and, when the welcome frost came, another of the old mediæval panic-breeders was dead.

Here is the condensed experience of one of the ablest surgeons in the South, "Dr. Henry Fraser Campbell, who has seen a great deal of yellow fever": Give hospitable refuge to all who are well, to those who have been infected and are about to be attacked, to those already overtaken in their flight from this dread pestilence, but exclude the cars that have borne them from their infected homes, and ventilate and purify the trunks that contain their clothes. The yellow-fever subject is laboring under the dire effects of a poison, and thousands of observations and centuries of experience have demonstrated that he can no more communicate his disease than can the subject poisoned with strychnine communicate the frightful tetanus to his friend or his nurse. As in the one instance the strychnine itself is required to produce another case, so in yellow fever a fresh supply of "disease-germs" is required to produce the "hæmogastric (blood and stomach) death." These "germs" or hypothetical elements of disease, many observations have convinced us, are transported in the cars arriving from infected ports, retaining their virulence through hundreds of miles of pure country air. The moral of all is, cleanse all things in and about your premises, and then, if a member of your household becomes in any way infected, possess your soul in enlightened calmness, isolate him, and disinfect and fumigate to the utmost extent, and there is little fear of its going beyond its first victim.

Plans to secure Disinfection of Clothes and Furniture among the very poor.—A new step forward has been taken in Liverpool, by the use of city apparatus for disinfecting bedding and clothing, as well as houses, and in some Continental towns they are establishing "funds" with which to replace

hopelessly infected articles, where to part with them is a hardship to the owners.

Household Treatment of obstinate Malaria.—We give below the treatment for severe malaria that Dr. Cyrus Hamlin learned from a Greek physician, and used in multitudes of cases with unvarying success. It exactly tallies with the latest German practice, which acts on the principle of, for once, *saturating* the blood of the malarial patient with quinine.

1. Dissolve two grains of tartar emetic in a glass of water. Take one third of this each morning, on waking, for three mornings.

2. Have ready twelve pills of quinine of three grains each. On the fourth morning take four of them, observing to wait fifteen minutes between each pill. Take four also on the two following mornings.

3. Then, for one week, take the quinine in diminishing doses each morning—ten, nine, eight, seven, six, five, four grains—after which stop the quinine ; then for a fortnight take five to ten grains of carbonate of iron before each meal. Diet, light but nourishing—soups, boiled mutton, etc.

Cholera.—While Koch and Pasteur are pursuing their investigations in Egypt and India at this hour, the health authorities are trembling lest our country be invaded, with the coming of summer, by this disease, through the medium of Egyptian rags, and energetic measures are being taken to enforce the thorough disinfection of the pestilential rags before they are shipped to this country (1883).

Cholera in Europe in 1884.—While this book is being put in type (September, 1884), one of the most destructive outbreaks of cholera ever experienced, judged by the number of deaths to the number of persons attacked—for about one half die—is raging at Marseilles, Toulon, and other places in France ; at La Spezia, Naples, and other places in Italy ; and at Alicante and other places in Spain ; while distributed along on the routes of communication between these, and in places where refugees from the great centers of infection have fled, there are multitudes of scattered cases. The intercourse be-

tween civilized nations has now become so frequent, so varied, and so geographically extended, that it is the calm judgment of the ablest medical minds and cholera experts, that it will be impossible to prevent its gaining a foothold in this country next year. But this grim prediction is largely shorn of its terrors by the advances that have been made during the last decade in knowledge of what the local causes are which create the general predisposition to the disease in any given place, what measures will counteract this, and also a true scientific knowledge of the organism that produces it, and the most efficient means of dealing with it, when once it has effected its lodgment in the alimentary canal of its victim.

The New York State Board of Health has focused all the existing light up to date in the following "memorandum" on

THE PROPAGATION OF CHOLERA.

"There is a specific infective cause of Asiatic cholera, called its contagium, by which it spreads as rapidly as the persons suffering from it may go from place to place. This contagium ceases to be repropagated beyond the sanitary lines which separate the cleansed, drained, and ventilated premises, and well-conditioned inhabitants, from those that are filthy, undrained, badly-sewered, crowded, and unventilated, or where polluted water or crude food and harmful beverages prepare the bowels for the fatal operation of the cholera-poison. The modern facilities of travel and transportation now tend to spread cholera over all the continents in a single year as readily as it was conveyed in the fifteen years of slower marching in its first great invasion.

"It must have three factors for its cultivation: 1. A center of pollution for its cradle. 2. A ship for its transport. 3. A number of towns prepared for its reception and development.

"The matters which a cholera-patient discharges from the stomach and bowels are infective, and when decomposing, or for a short time remaining in wet or foul places, or in water used for drinking, become a prolific scource of propagation of the disease, and lines of danger are conspicuous in Egypt and

all the Mediterranean countries, and they exist in all the European cities whence emigrants depart for New York and other American ports. The sanitary neglects that have prepared for a lodgment and repropagation of the cholora in filthy places and sodden grounds are found in every port, city, village, and manufacturing town, and in many a rural neighborhood and hamlet.

"The presence of excremental filth, uncleansed dwellings, stagnant pools, polluted water, and of great numbers of badly-housed and imprudent people in hundreds of places in this State, will invite cholera whenever it appears in any city on our Atlantic seaboard.

"The exclusion of cholera from the ports of our country, and the instant arrest and suppression of it as a malady which has subtle ways of spreading, is the first duty that the sanitary authorities in this State have provided for, and now, before the exotic infection has come, let all local boards of health and all householders lose no time in enforcing such thorough scavenging and cleansing, such cleaning of sewers, drains, and ditches, and such ventilating, drying, lime-washing, and disinfecting of cellars and all damp and unclean places, that, if cholera comes, its infective germs shall find no soil or foul surface in which to propagate epidemically.

"Cholera is so little contagious, in the sense in which small-pox and typhus are called contagious, that if proper precautions are taken there is scarcely any risk that the disease will spread to those who nurse or otherwise closely attend upon the sick."

It is universally acknowledged that cholera is never absent from Hindostan, its birthplace and starting-point; but Mr. Edwin Chadwick reports that, even in Calcutta, its very hot-bed, drainage-works and the introduction of pure water have reduced the death-rate to a fraction of what it formerly was.

But the point where the lay mind "fails to see the connection" is this. It asks, "What have impure air or stagnant pools of excremental filth to do with the fatality of the disease when it is proved that for its production the cholera-bacillus needs to

be introduced to the alimentary canal *via* the stomach, and that the majority of carefully traced cases came from drinking infected water?"

The plow does not sprout and spring up into a stalk of maize, but it breaks and mellows the soil, so that, when the seed-corn drops, it takes root and grows. The stagnant pool produces a miasm, that, pervading the system of the man who lives in it, keeps the bowels in an "irritated," tender, and ready-to-be-attacked condition—prepares the soil for the seed.

The alimentary canal is lined with a delicate and sensitive mucous membrane, that is easily brought into a state that doctors call "irritated"—i. e., congested or inflamed; one meal of bad or indigestible food will produce this effect, hence the constant warnings of medical men against eating overripe or unripe fruit, or other food that will tax the digestion unduly, in cholera seasons. The mucous membrane is covered by a most delicate epithelium, and this is *the* point of attack of the cholera-bacillus, which, if it has escaped destruction by the acid gastric juice of the stomach, fastens itself in the epithelium of the intestine, and multiplies with fearful rapidity, spreading over and disorganizing large patches, and bringing them into a condition that Dr. J. C. Peters compares to the effect of a fly-blister on the skin. From these diseased patches are poured out with destructive rapidity those watery discharges that are the characteristic of the disease, which rob the blood of its serum and produce "collapse."

There are thousands of people who, from unsanitary environments, have perpetual enteric trouble—i. e., constantly irritated alimentary apparatus. They are never as well as they were meant to be, and when this extra enemy appears they can not resist its attacks, and succumb. When we read that the "scourge has burned itself out" in any place, it simply means that it has killed off all these ready-made victims, and now has only the sounder fraction of the community on which to wreak itself, and they can and do withstand it.

The experience of Marseilles and Toulon confirms anew the influence of existing filth in preparing material on which the

specific infection can work. Both have practically tideless harbors, and the descriptions of eye-witnesses of the filthy conditions of the Italian quarters (in both it took root at once there) are utterly repulsive, and are only surpassed by the hideous conditions of those towns in Italy itself—Cuneo, La Spezia, and Naples—where it has made the greatest ravages. As there is a large "patch" of Naples in the city of New York, it is suggested that the health authorities should cleanse and purify it to the utmost during the coming winter.

Necessity of Prompt Action in Cholera.—There is hardly any disease where time forms so important an element in the problem of controlling it; an hour's delay may make all the difference between life and death.

Household Treatment of Cholera.—In the treatment of such a formidable disease, it would be presumption to act on anything but the ripest experience available, and fortunately we can avail ourselves of that of the American missionaries in Constantinople, which has been carefully written out by Rev. Dr. Cyrus Hamlin, now President of Middlebury College, but who lived in Constantinople thirty-five years, during which time there were four invasions of cholera, in one of which (1865) the mortality was so great that all business finally ceased, and nothing but the burial of the dead could be attended to. He and his associates treated many hundreds of cases successfully.

He says: "On the approach of cholera, every family should be prepared to treat it without waiting for a physician. It does its work so swiftly that, while you are waiting for the doctor, it is done. The attack will probably be made in the night: your doctor is away; you must treat the case yourself, or it will be fatal. Send for the doctor, but don't die before he can arrive. Be prepared to confront the enemy, and not give him immediate possession.

"Above all diseases, cholera gives at least a few hours' quiet and friendly notice of its approach to the individual. While the disease is prevalent in a place, almost every one experiences slight disturbances of digestion. Doubtless, persons notice the

slightest nausea or pain, and suffer through the imagination; but, when diarrhœa commences, however painless and slight, it is in reality the skirmishing party of the advancing column. It will have, at first, no single characteristic of Asiatic cholera; but, do not be deceived, it is the cholera, nevertheless. Wait a little, give it time to get hold; say to yourself, 'I feel perfectly well, it will soon pass off,' and in a short time you will repent of your folly in vain. I have seen many a one commit suicide in this way. In some cases the diarrhœa continues for a day or two; the foolish person keeps about, then sends for a doctor, but suddenly sinks and dies before he can arrive.

"Sometimes, though rarely, the attack comes on with vomiting, but, in whatever way it comes on, it is sure to hold on. In a very few hours the patient may sink into the *collapse:* the hands and feet become purplish; the countenance, at first nervous and anxious, becomes gloomy and apathetic, although a mortal restlessness and raging thirst torment the sufferer, while the powers of life are ebbing. The intellect remains clear, but all the social and moral feelings seem wonderfully to collapse with the physical powers. The patient knows that he is to die, but cares not a snap about it. In the case of intemperate persons, the attack is often sudden and violent and fatal; but, if persons of regular and hygienic lives detect the first symptoms, they have nothing to fear."

Course of Treatment in Cholera.—Here, again, Dr. Hamlin speaks: "1. The patient, however well he may feel, should rigidly observe perfect rest—to lie quietly on the back is one half the battle; in that position the enemy fires over you, but, the moment you rise, you are hit. For stopping the incipient diarrhœa the following mixture—perfectly efficient in thousands of cases—has fully established its reputation:

"*By measure:* One part of laudanum.
One part of spirits of camphor.
One part of tincture of rhubarb.

"Thirty drops for an adult, on a lump of sugar, or given in a little water, will often check the diarrhœa; but, to prevent

its return, care should always be taken to continue the medicine every four hours, in diminishing doses : twenty-five, twenty, fifteen, ten ; while careful diet is all that is needed. (*This is labeled Mixture No. 1.*)

"In case the first dose does not check the diarrhœa, continue to give it in increasing doses—thirty-five, forty, forty-five, sixty—at every movement of the bowels. Large doses will produce no injury while the diarrhœa lasts ; when that is checked is the time for caution. *I have never seen a case taken thus in season that was not controlled.* But some cases of advanced diarrhœa, and especially of relapse, paid no heed to it whatever. When this has become apparent, this has been my course : Prepare a teacupful of starch, boiled as for starching linen, and stir into it a full teaspoonful of laudanum for an injection, and use one third after each movement of the bowels. In one desperate case, abandoned as hopeless by a doctor, I did not stop the diarrhœa till the seventh injection, which contained a teaspoonful of laudanum. The patient recovered and is in perfect health. At the same time I used prepared chalk in ten-grain doses, with a few drops of laudanum and camphor to each ; but whatever course is pursued, *it must be followed up and the diarrhœa controlled, or the patient is lost.*

"2. *Mustard-poultices* should be applied to the pit of the stomach, and kept on till the surface is well reddened. If the extremities are cold, use chafing, hot flannels, bottles of hot water, etc., till natural heat is restored ; taken in time, it is most manageable, but give it a little headway and you must then fight for life, with the odds against you.

"3. When the attack is more violent, the first onset being marked by vomiting, cramps, and colic-pain, the following, labeled *Mixture No. 2*, has been found most useful : *By measure :* one part of laudanum, one part of tincture of capsicum, one part of tincture of ginger, one part of tincture of cardamom-seeds ; dose, thirty to forty drops in a little water, to be increased according to the urgency of the case. In case the first dose should be ejected, the second, which should stand ready, should be given immediately after the spasm of vomit-

ing has ceased. The vomiting was perfectly controlled by, at most, the third dose. Large mustard-poultices were also invariably applied to the stomach, bowels, calves of the legs, etc."

Collapse.—"This is simply a more advanced stage of the disease. It indicates the gradual failing of all the powers of life. It is difficult to say when a case has become hopeless; but the blue color, the cold extremities, the deeply sunken eye, and the vanishing pulse, are no signs that the case is hopeless; scores of such cases have recovered.

"Give in addition to Mixture No. 2, *brandy*, a tablespoonful every half-hour. Bottles of hot water surrounding the patient, mustard-plasters, and friction, will often, in an hour or two, work wonders.

"In cases of *sinking*, brandy at intervals is all-important. I undoubtedly saved one valuable life by continuing its use during a whole night; at seven in the morning the patient fell into quiet slumber and was saved."

Thirst.—"In these and all advanced cases thirst creates intense suffering. The patient craves water, and as sure as he gratifies the craving the worst symptoms return, and he falls a victim to the transient gratification. The only way is *to have a faithful friend who will not heed his entreaties.* The suffering may be safely alleviated and rendered endurable. Frequently gargling the throat and washing out the mouth will bring some relief. A spoonful of gum-arabic water or of camomile-tea may be frequently given to moisten the mouth, and Sydenham's white decoction may be given in small quantities both as nourishment and drink. In a day or two the thirst will cease, its intensity lasting, usually, not more than twenty-four hours."

The Typhoid Fever that follows Cholera.—"A typhoid state for a few days will follow all severe cases; there is nothing alarming in this; it is rarely fatal; patience and careful nursing will bring all right: the greatest danger still is from drinking too freely."

The Cholera-Doctor's Complete Outfit, as made up by Dr.

Hamlin, is this : "We considered ourselves completely equipped with a small hand-bag containing Mixture No. 1 ; Mixture No. 2 ; a few pounds of pounded mustard ; a bottle of brandy ; a paper of gum-arabic, and a paper of camomile-flowers." After years of observation, Dr. Hamlin learns of no treatment so successful as the above.

Contagiousness of Cholera.—On this point Dr. Hamlin says : "The American missionaries in Constantinople always acted upon the belief of its not being contagious. They visited the filthiest abodes of sickness and death every day ; worked over the sick and dying, often breathing an atmosphere dank and disgusting with the smell of death ; and they all came through the long campaign of six weeks unharmed : but *they used every possible precaution, watched their own symptoms, and repelled the first advances.*"

Dr. J. C. Peters, a high authority, says : "Cholera is not, and never has been, in the air ; and if it came to New York, I should feel just as safe within arm's reach of a patient, provided the drains in my house did not communicate with those in his, as if he were a mile away ; and history proves that I am right."

The latest investigations of Koch show that water and moisture furnish the media in which the cholera-germs proliferate most rapidly, and that dry heat is the most fatal enemy to them yet found.

Dr. Peters recommends that nurses and doctors should wash their hands in vinegar-and-water while attending cholera-patients ; and he thinks common table-salt and vinegar, used separately, and in fairly large quantities, as condiments for food, will prove excellent domestic prophylactics.

The Inciting Causes of Cholera.—Dr. Hamlin says : "I have personally investigated the inciting causes of hundreds of cases. Improper food, or intoxicating drinks, or both together, will stand for three fourths. Exposure to a cold draught while in perspiration, great fatigue, anxiety, fear, all figure among them : if a person can avoid all the foregoing, he is as little liable to cholera as to being struck by a comet."

To these, Dr. Peters adds, "Air impregnated with the products of fermenting excrement, a hot, stagnant atmosphere, excess in eating, undue abstinence from food, licentiousness, impure drinking-water, and above all direct exposure to the contagium of the disease."

A series of propositions, of high scientific value, were formulated under the direction of Surgeon-General J. M. Woodworth, of the Marine Hospital Service, after the epidemic of 1873; a few of them are of direct practical import:

"Malignant cholera is caused by the access of a specific poison which is contained primarily, so far as the world outside of Hindostan is concerned, in the vomit, stools, and urine of a person already infected with the disease.

"The dried particles of cholera-poison may be carried (in clothing, bedding, etc.) to any distance, and when liberated may find their way direct to the alimentary canal through the medium of the air—by entering the nose and mouth and being swallowed with the saliva—or, less directly, through the medium of water or food in which they have lodged."

Many cases are on record of persons acquiring cholera from eating articles that had been handled by infected persons, and particular infected wells have been proved to have distributed the virus to numbers of persons. In Berlin, during the epidemic of 1866, in the houses supplied with good water the number in which cholera occurred was 36·6 per cent, while in the houses supplied with bad water the percentage attacked was 52·3. In 1859, according to Dr. Parkes, Copenhagen was supplied with good water, and, although cholera had been very severe there on its previous visits, there were then very few cases. Professor Förster, of Breslau, also shows that five towns of Silesia are entirely free from cholera, even when it has been brought to its doors, the supposed preservative condition being "a water-supply brought from a distance which can not be contaminated." A still more striking proof of the value of this precaution is the fact, cited by high authorities, that at Haarlem, Holland, in 1866, as in 1849, cholera prevailed with great intensity except in one part of the city,

inhabited by bleachers, who had obtained a separate and fresh source of pure water. Our great seaboard cities, where it will be brought, if it comes, are mostly supplied with pure water now, and so far may feel safe.

The danger attending the use of ordinary privies, that may have been infected, is obvious, and Niemeyer, of Germany, advises people to use night-stools instead, during an epidemic.

Measles.—This, though a comparatively mild contagious disease, may be developed into a severe one by a want of the two great remedial forces, light and air, as appears from this newspaper item :

BALTIMORE, *July 15, 1883.*

A malignant type of measles has appeared in St. Mary's Industrial School for Boys, a reformatory institution a short distance from this city, under the charge of the Xavierian Brothers. Up to last night there had been ten deaths since Wednesday, and there are a number of sick. The form of disease is generally known as camp-measles, and in this instance it is said by the physicians to be due to overcrowding and imperfect sanitary regulations. There are now about four hundred and twenty boys in the institution, while its capacity is said to be only two hundred and fifty, with the building badly ventilated.

The plain moral of the foregoing is *cleanliness*, for in all the above diseases it is the universal testimony of physicians and scientists that filth or sanitary neglect of any kind directly augments their virulence—is like adding fuel to their fire.

CHAPTER IX.

OUR NEIGHBOR'S PREMISES.

Who is our Neighbor?—Sanitarily considered, he is the man who lives next us, in the old literal sense of the word; but he also is the man whose premises the breeze can sweep, and bear its particles to our lungs and blood, at whatever distance, or at whichever point of the compass he abides. Whether we live in the country, and our neighbor's cess-pool leaks into our well, or he spreads a morbific fertilizer on his land where the poisonous effluvia can enter our windows; or in the city, where his decayed or ill-made waste-pipe, laid next our wall, lets the sewer-gas into our house, or a choked and broken drain infects our soil—we have a direct interest in his house and grounds. Nothing more clearly shows the essential brotherhood of men than the fact that the vital conditions of life are the same in all ranks, and the neglect of the poor by the rich, in sanitary matters, bears within itself the seeds of retribution. A man may live on the splendid "avenue," in a mansion plumbed in the latest and costliest style, but if, half a mile away, in range with his open window, there is a "slum," or even a neglected tenement-house, the zephyr will come along and pick up the disease-germs and bear them onward, distributing them to whomsoever it meets, whether he be a millionaire or a shillingaire, with a perfectly leveling and democratic impartiality.

Nineteen years ago there occurred in a school in one of the most salubrious spots in Massachusetts, one of those terrible outbursts of typhoid fever which, up to about that epoch, had been looked upon as chastening visitations of God for moral delinquencies, but which, in the light of modern sanitary

science, are recognized as the strict adjustments of penalty for His broken physical laws. There were many deaths. The number of cases bore a frightful percentage to the number of pupils, showing how all-pervading, on the grounds, the cause was. Among the survivors, there are at this day enfeebled invalids who have never known complete and joyous health since, and who can but reproach the ignorance and neglect that sapped the foundations of their life. Investigation disclosed the cause, in inadequate sanitary arrangements and bad drainage, the more inexcusable as the situation admitted easily of good drainage. But in addition to the victims on the premises, there was a large company of sufferers who didn't even live on the same street with the institution. It was in that terrible summer (during the war) of 1863, abnormally hot, when week after week there was no rain, and the sun looked like a dull copper disk through the murky air. Nature herself seemed animated by a revolutionary spirit. For three weeks preceding the sickness there was no breath of wind except from the northeast in this region of habitual west winds. This proved an important factor in the sequel, for there was a wide space, extending in a southwesterly direction from the focus of infection, which more than took in one entire street of houses, placed at just the right angle, which comprehended within its wretched limits a literal *windrow* of victims. Some of the distinctive marks of the epidemic were too peculiar to leave any doubt as to its identity of cause; while the thickly settled region to the northeast was exempt, and all other parts of a town of ten thousand people, save here and there was a case in an unfortunate day-pupil, which bore additional witness to the operation of a local cause. Who, then, was neighbor unto these unfortunate premises? The eloquent Kossuth popularized the phrase "solidarity of nations," and it is beginning to be perceived that in sanitation there is a perfect solidarity among all the inhabitants of any given town or city. An apple, to be sound, must not have one "speck," no, not a pin's head of decay, or the beginnings of ruin are there; a town with one focus of zymotic disease is unsound.

It is the appreciation of this fact that has given such impetus to the effect of a pamphlet written in London, and called "The Bitter Cry of Outcast London." The cry has penetrated up through the House of Commons, and on upward through the House of Lords, to the very foot of the throne. Mr. Gladstone declares, "The care of the public health is the highest duty of the statesman"; and Lord Salisbury has been moved to bring forward a measure by which government itself is to engage in a scheme *for the better housing of the poor*. It would be delightful to believe that this is the outcome of a truly Christian response to the question, "Am I my brother's keeper?" but the cold fact is that mainly it is the fruit of an *enlightened selfishness*, which plainly sees that St. Giles must be purified before Belgravia can be safe. Americans can learn much by studying the successive steps by which the entire public mind of England has been brought into the condition of conductivity, which has allowed this electric thrill to pass from lowest to highest. Ten years ago the "cry" would have fallen on comparatively dull and heedless ears.

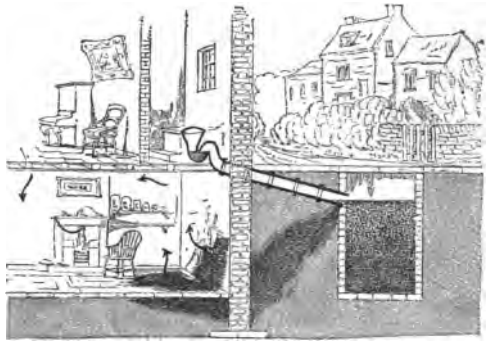


FIG. 42.—Basement made damp and unhealthy by overflow of cesspool on adjoining premises.

Our Interest in the House around the Corner.—About eight years ago one of the most prominent firms in New York built a magnificent store in which to carry on their own business. No care nor expense was spared to make it perfect in every respect, and especial thought was bestowed on its sanitation; they arranged a large glass-inclosed "office" on the second floor, which was admirably lighted by two large "plate" win-

dows. It was to be constantly occupied by about a dozen clerks. The firm moved in, in December, and all went well till the warm days of spring caused the opening of the windows aforesaid, when lo! one after another of the clerks fell ill, one of typhoid fever, several of malignant sore throat, and two of diphtheria. At first it was thought that the illness came originally from some cause disconnected with the building; but when seven men were simultaneously detained from business, one lying at the point of death, and those who still remained at work were complaining of lassitude, headache, etc., it was thought best to call in an expert, although the sanitary engineer, as we know him, was then a highly novel figure. The cause of all these woes was soon localized. The house on "the street around the corner," once a fine family residence, was now given over to tenants, and the plumbing had all the worst features of the worst style; but the special cause of mischief was a ventilating-pipe that ran from a fixture in the basement to about four feet below the sills of the office-windows. There was scarcely a trap in the house, and absolutely no barrier between the street-sewer and it. There was no further wonder as to where the diphtheria had originated, especially as this pipe was carried up in the angle where the buildings came together, and was thus thoroughly screened from the action of those "airts that blaw" with cleansing visitation over spots that otherwise would be fatal. The owner proved most intractable when asked to put his premises in order, and finally the firm were compelled to buy the property in self-defense. A thorough sanitation followed, and those glass-inclosed clerks have "lived happy ever after." Law has made some steps forward since then, though much remains to be desired. While the Health Board are pushing their unwelcome, but educated and most useful noses into many premises neglected in a similar fashion, they ought not to overlook a class of structures which are "neither one thing nor another." They were once dwellings and are now stores, having been remodeled in the slightest and most shifty fashion, and are occupied during the day by hundreds of young men and young women, some of

whom, from poor food and narrow quarters at home, are ill fortified against the onsets of micro-organic disease. These are ground between the upper and nether millstones of grasping and penurious landlords on the one hand, and struggling tradesmen on the other, who know that any "improvements" will be sure to make themselves felt when the lease is to be renewed. A systematic inspection of this class of buildings, faithfully written out, might possibly constitute a bitter cry of young clerkdom.

The Way in which the Lowest Tenement-Houses poison the Neighboring Air.—Take an example found in that part of New York inhabited by the Polish tailors. The cellar is made the home of chickens, ducks, geese, and Guinea-fowls—five hundred have been kept in a cellar—and one inspector found a hall-bedroom occupied by three people and fifty fowls! Of course it is against the law, and of course it creates a nuisance, but the ingenuity of the breeders in evading the law is boundless, so that when the inspector comes, not a chick can be seen; they have been hustled into coops, and lifted into a licensed vender's cart, and it is illegal to touch any article so protected; or they are "cooped" *pro tem.* in a small compartment of the cellar prepared for emergencies, against the door of which, innocent-looking coal has been banked, the whole operation having taken but the few minutes since the faithful ally has warned the owner of the approach of the officer. The inspector once found fourteen chickens and three live turkeys in a refrigerator, against which he accidentally stumbled and elicited thereby a "chuckle-chuckle" that betrayed the nearly smothered creatures. This may be called the foundation stratum of an odor which, before it passes out at the top of the fifth story, will certainly be strong enough to "smell to heaven." The particular building in hand has five stories of twelve rooms each; in it live thirty-two families, averaging five persons each, and all or nearly all take boarders. Question one of them directly, he stoutly denies it; but, ask the lower floor as to the habits of the top floor, and you find that every family has lodgers, and the masses of bedding that cumber the fire-escape

from top to bottom confirm the tale. Very possibly the owner or agent, who has scented danger in seeing the sanitary inspector about, comes in and roundly rates the tenants for cumbering the escapes, and the beds are drawn in, to go out again when the inspector's back is turned. Think of it! ten beds in two small rooms—one of them "dark"; originally light did come in at the rear window, but it has been shut out by a large new building on "the other street." What must be the state of the air in one of these bedrooms with five people in it, and what must be the state of the blood of the sleepers? Of course its power of vital resistance is so lowered that when a newcomer arrives among them "off ship" from Europe, and brings typhus, it spreads like a spark in tinder. The outbreak of typhus in the Shiloh Shelter lodging-place came about in precisely this way, but the packing was carried to the extreme, as there were just as many twenty-inch beds as could be placed like candles in a box on the floor; every puff of air from it must have infected the adjacent atmosphere into which it diffused itself.

It is no wonder that the children in these "plague-spots" are pale and scrofulous, and that they perish in hundreds in the hot days of summer, although, bad as their air is, it is comparatively better than their food.

Can the "Slums" be reformed out of Existence?—Probably "yes." How? Through the agency of enlightened selfishness. Many who have had great experience of *slumdom* will say that this is a vain expectation, but new forces are operating and the upper ten thousand are learning that their sanitary welfare is indissolubly connected with that of the lower ten millions, and it is the perception of this truth that has caused the "wave of emotional interest" in the condition of the poorer classes that is now sweeping over England with an almost tidal force, and which will certainly reach our shores ere it subsides. The work to be accomplished is gigantic. The class to be elevated resent supervision, and care little for health or cleanliness till taught, but already some great and definite steps forward have been taken. It has been demonstrated in many of the most crowded parts of London that

Healthy Homes make Healthy People.—At the present hour there are areas in Glasgow, Edinburgh, Liverpool, and London, covered by salubrious, healthy homes, that ten years ago were as bad as it is possible for human habitations to be; and this result has been brought about through knowledge attained by the erection of houses that were first undertaken as humane enterprises, but, to the surprise of all parties, it has been shown that as private enterprises such buildings can be made profitable, and so, for the regeneration of the ulcerated spots, we come back to the action of the unfailing law of supply and demand; but the demand is growing to be an enlightened demand, and the supply is being furnished in accordance with the real wants of the working-man.

"Philanthropy and Five per Cent." The most successful of the London Artisans' Homes.—In all the annals of the brotherhood of man, of all the attempts of the stronger to aid the weaker, without robbing the latter of one *iota* of honest self-respect and manly resolve to exist by self-help, there is none more interesting than the story of the operations of the London Improved Industrial Dwellings Company, of which Sir Sydney Waterlow is chairman; and the culminating sanitary fact, demonstrated by accurately kept statistics, that in these buildings, erected in the most populous parts of London, the death-rate has been reduced to 16·4 per 1,000, in the year 1881, as against 21·2 in London generally, and against 31·8 in New York in the same year, may make us all wish that we too might become their tenants.

It may encourage those who feel that all the agitation of the subject produces but meager fruit, to know that it has taken more than thirty years even in England for this idea to be successfully worked out, and that the practical solution of the problem was finally wrought out by a man who was himself a practical mason. The idea of *improved dwellings for artisans* lay as a humane dream in the mind of the noble Prince Consort, who exhibited a "model lodging-house" at the first Exposition in 1851; and, stimulated by his sympathy and encouragement, several unsuccessful attempts were made, but

finally the deliverer appeared in a man from the ranks of the working-men themselves. Viewed as steps in the right solution of a mighty problem, the unsuccessful building companies did a most important work. They helped to clear the subject of all encumbering rubbish, and to show what the laboring-man did not want, when at length the two men who have wrought out the complete solution of the grand problem met, each a splendid example of the "square peg in the square hole." The able financier—a wealthy man of broad, generous views, the head of a large printing establishment—Sir Sydney Waterlow, agreed to advance money to the practical mason. Mr. Allen, the mason, labored with his hands, but his heart was full of good-will to the poor, among whom he was born and had lived for nearly half a century. He saw them daily everywhere around him suffering from want of "good, *healthy*, and *tasteful* homes." His head became full of plans. He said, "Hitherto the home of the working-man has been neglected, so he has resorted to the tap-room, where alone he has found brightness and mirth." Sir Sydney employed him as a mason, and his soul was so "enthused" that of course he urged his plea. Sir Sydney listened with attention and interest, and finally ended by inducing three wealthy friends to join with him in advancing the money to Mr. Allen, "provided that, on examination of the plan by a competent architect, it should be found to be on strict legal and architectural principles, so as to give safety to every room and to every individual in it." The result was favorable, and, from that time (1863) to this, Sir Sydney, with others, forming a limited company, have continued to build and extend their operations, retaining Mr. Allen as their architect and chief superintendent, till they have provided *healthy* and *tasteful* homes for over twenty thousand persons, and have incidentally supplied answers to many questions that are being asked on all sides by the sanitarian and philanthropist.

Mr. Allen realizes that "man can not live by bread alone," and believes in cultivating the æsthetic part of his nature. A well-trained flower on a window-sill reveals to him a better tenant for a newly built house than a man indifferent to beauty.

Yet he is a workman, and uses his trowel if need be, and dresses as a workman should while at his work. One element in the success of this company has been the judicious selection of sites, the prime factor being proximity to the tenant's work. Abundant evidence has proved that the working-man will make almost any sacrifice for the sake of being near his work; this means a longer time for his well-earned sleep, an exemption from the anxious trepidation that seizes him when he has delayed a minute or two to help the wife put some little domestic detail to rights, and an occasional "docking" of wages for lost time. Yes, the mechanic wants to be near his work.

The aim in these buildings was to insure safety from fire, and immunity from contagious disease. These were secured by allowing no upward ventilation, by fire-proof outside stairways, and iron-tied roofs with asphalt coverings. They wholly abolished the long, common corridors, so familiar in tenement-houses, and one of the most efficient means of diffusing contagious diseases. They provided for ventilation by a style of construction which, when two or three doors are opened, gives free access of air to every room; of course, no room is without a window "giving" to the free, unobstructed air; and yet all this, as Sir Sydney himself testified, on the occasion of the complimentary dinner given him at Delmonico's in 1881, costs forty-seven cents per room per week. The average wages of the occupants is eight dollars per week, and yet the company pays five per cent dividends to its stockholders. Its stock is quoted at 112, and its bonds are in good demand; large reserve funds are laid aside each year. There was at one time a prejudice in the minds of the laboring man against "industrial dwellings"; he fancied that he must surrender a part of his manliness when he became a tenant in them. Mr. Allen knew just how to deal with this proud sensitiveness, and so caused it to be thoroughly understood that the transaction was purely a business affair, the only conditions enforced on the tenants being—1. That they must *pay their rent*, thus enforcing the moral of living within the means; and, 2. That they will be allowed to do nothing that will interfere with or annoy others

in the absolute enjoyment of their homes. A deposit of $1.25 is required of each tenant as security against broken windows and lost keys.

Sir Sydney says further: "The important rule for all who build this class of houses is, to provide what the working-man really wants, not what he does not want, nor what philanthropists think he ought to want."

It will yet be discovered that the home is the very core and center of Anglo-Saxon national life; so it is pleasant to think that one of the prominent features of the Waterlow-Allen plan is to furnish to each household a complete isolated home; and just as all missionaries find that physical surroundings have a powerful influence in elevating spiritual character, so have these *home* missionaries found that elevation of the man has followed on his entering a "neat, healthy, tasteful" home. Sir Sydney says: "It has been found most profitable to place the buildings as near as possible to the places of business of the workmen—their time, chances of employment, children's earnings, and social amusements being thus of enhanced value to them"; and Mr. Allen, sustained by that enthusiasm which is a true voice of God in the soul, a genuine inspiration, says: "I build for the future. I have lived and toiled among the working-men of London over forty years, and I know their necessities and desires. They have been all that while steadily improving. I feel sure that some time after I am dead every mechanic will live in such buildings as we are now erecting." We may be sure that the work on these buildings partook of the thorough, solid character of the two men who erected them, and, as they were the fruit of a lifetime of observation, we append the following sketch of the plan on the opposite page: "The building is of brick, with stone finishing. It is five stories high. The rooms are eight and a half feet high from floor to ceiling. Front, about one hundred feet on the street; depth, a little over forty feet. The central part of the front line is set back a little way, and has four bay-windows on each story. The two end portions, therefore, present the appearance of wings added on each side of a more elaborately constructed center. The structure

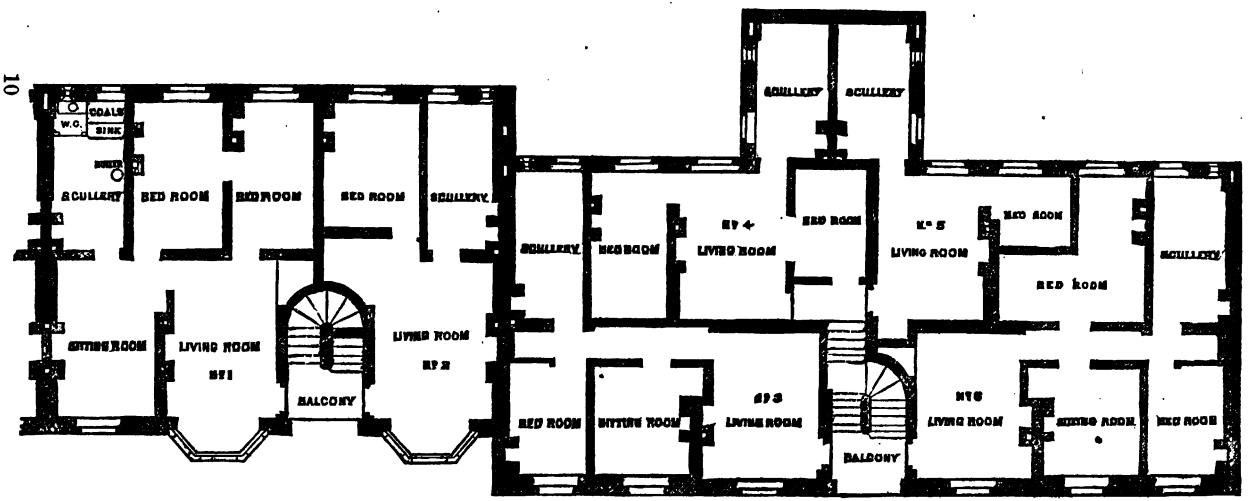


FIG. 43.—Waterlow-Allen Building, London.

has a certain degree of refinement and elegance about its exterior, which would make it not inappropriate for a fashionable street. Yet it is filled wholly with a series of small tenements, very convenient and perfectly lighted and ventilated." The outside stairways, when contrasted with the hideous fire-escapes that deform any building to which they cling, must be considered a specially happy thought, both for beauty and real utility. The annexed table shows the cost at which the complete "tenements" are furnished:

Number.	Number of Rooms.	Weekly Rent.	Per Annum.
1	Four	$2 25	$117
2	Two	1 50	78
3	Three	1 87	97
4	Three	1 56	81
5	Two	1 37	71
6	Four	2 25	117

The tenements contain the number of rooms above stated, *each* plus a scullery or wash-room attached, containing closet, sink, coal-bin, boiler, etc., as marked in No. 1. The perfect privacy is next best to having a house all to one's self, and the reduction of the average death-rate from forty in the thousand to eighteen demonstrates that a man's health is not so dependent on the absolute amount of cubic space given him, as on that which he does have being perfectly pure.

These houses are constantly occupied, and, among all the various buildings of the company, only one has ever stood even partially idle, and this was at Shadwell, whose local industry was temporarily depressed.

The example set in England has not been lost on America, as the well-known experiment of Mr. Alfred T. White in Brooklyn, the erection of the improved houses at Seventy-first Street, and still better those on Charlton Street, testify in New York. Many blocks in Boston, and the working-men's homes in Philadelphia, show that the right leaven is working.

The foregoing example absolutely demonstrates that healthy houses make healthy people, in spite of being in inferior and

previously supposed insalubrious localities. It also shows that, economically built and administered, they form an investment that brings a good constant interest, and that they are wanted; but, above and beyond all this, there seems to be here a germ of hope that there will yet be built a new style of homes for a class that are well represented by

The Forgotten Journalist and the Overlooked Bank Clerk, *et al.*—Many of these work as many hours as, and get but little more than, a skilled artisan. They are often men of culture and refined tastes—too refined to make any moan at the hardships of their lot; they do not get together and form "unions" and radical clubs, yet certainly they are as worthy of sympathy as are the distinctively so-called working-men. They generally are compelled to take cheap rents in the unfinished and notoriously unhealthy city suburbs, or seek homes in some rural town, which, with all the mitigations of "rapid transit," eats two good hours out of the day. They leave their homes before their children are fairly up and dressed, and, after all the little errands on the way home are done, and the last vexatious delay is conquered and the dinner eaten, the bed-time is come; and but for the blessed interposition of Sunday, these men would never have an opportunity to become acquainted with their own offspring. They are often men who love books and harmonious æsthetic surroundings, and those pleasures of the intellect that they could command easily in the city, but which are missing in that "slack-water" belt that encompasses all populous cities, that is too far to be reached after entertainments, without robbing them of the sleep that is supremely essential to the health that is their main capital. Out of the urgent necessities of this numerous class, and the versatile New World tact that seizes and appropriates all that is most desirable in Old World experience or modern invention, re-enforced by the impulse for *improved dwellings* that is moving Anglo-Saxondom, it is to be hoped there will yet be evolved the

American "Flat."—Hitherto the attempts to supply safe, healthy, convenient, tasteful homes for the above-named class, at a rental that would leave any adequate margin for other liv-

ing expenses, have been signal failures. We already have the Irish "flat" (tenement-house), with its long, dark passage-ways, and stairs reeking with all manner of filth, redolent of smells unendurable to anything but a garlic-hardened nostril; its windows opening into the smallest possible space that can form a legal "light-shaft," as different as possible from the windows that let in light to the Waterlow-Allen buildings, and altogether constituting a noisome whole, where children can not grow up into health. Then we have the elegant "French apartment." Here we get decorated wash-bowls, parquetry-floors, mantels inlaid with plaques bearing all manner of birds, beasts, and creeping things, and many "charming effects," but the price is to the modest pocket of the clerk a complete inhibition: four thousand dollars per annum has been paid for one in a very fashionable building, without the privilege of boiling an egg for an invalid, above the glittering tiled hearth. Quite spacious houses can be rented in unfashionable quarters for what one of these commands.

The entire class of professors, teachers, sub-editors, musicians, and people whose time is their capital, to whom it is vital to be able to keep their engagements, artists and myriads of clerks, who must take the enjoyments of life day by day, as they ago along, or miss them altogether, are now compelled to spend a large percentage of their waking hours in transit, or bestow themselves in houses that have fallen from the high and well-cared-for estate of family mansions to "rented" houses, so poorly adapted to the exact wants of their occupants as to be best described by "ill-convenient," but representing so large a capital as to furnish an apology for a rate of rent that is crushing to the tenant. If some wise and humane man, or "syndicate" of men, could be moved to erect homes for these, and be content with a rate of interest that they wouldn't shrink from owning if questioned by the Master—

> "What hast thou done . . .
> For God and man,
> From the golden hours of bright-eyed youth
> To life's mid-span?"

we might see a new species of apartment-house that would combine the safety and healthfulness of the Waterloo-Allen blocks in London, the tastefulness of the villa-residences that are springing up in its suburbs, with the superior mechanical adaptations of the best American houses, and that virtual application of the co-operative principle found in the best-managed apartment-houses, which, with elevator and janitor, bring an infinite relief from murderous stair-climbing and petty cares.

The Ideal.—How can such a structure be produced? The answer is similar to the artist's celebrated "with brains, sir"; but here the brains must be applied to studying how to obtain with the greatest economy the items which follow, that go to the making of what may be aptly named the Hygeia apartment-house: safety from fire; security from disease-germs; light and air in every room; healthful ventilation and heat; harmonious and æsthetic "finishing"; play-ground for children; perfect privacy, by providing a complete home in each apartment, and peace of mind by a low rent—and the first and greatest of these is peace of mind. The site must, of course, be judiciously chosen near the great arterial lines of inter-urban transit. There is plenty of good ground now cumbered with rickety and unsanitary buildings, that would be proffered if it were shown that such buildings can be made to pay. It would require sound and informed judgment to decide just where ground-rent and the cost of lifting neutralize each other, and this would determine the height. There must be a natural law to prevent buildings from growing up into the sky, just as there is for trees; and it is not demonstrated yet whether those lofty structures, that chill a whole street by their shadow, and cut off the sunlight from a block of back yards, will be profitable to their owners in the long average of years, or leave them in the condition of the men who were "confounded" at the Tower of Babel.

The site and the number of stories decided, the building must be absolutely fire-proof—of course, lessening the cost of insurance. It must be made proof against the miasmatic exhalations of the earth, so that the foundations should be laid

so strong and deep as to defy cracking and settling, and the cellars should be thoroughly asphalted. To secure it against disease-germs and all manner of sewer emanations, the plumbing should be carefully planned out, and perfectly executed. There is a rage just now for a costly style of what may be called "show" plumbing, where bath-rooms are fitted with brass pipes

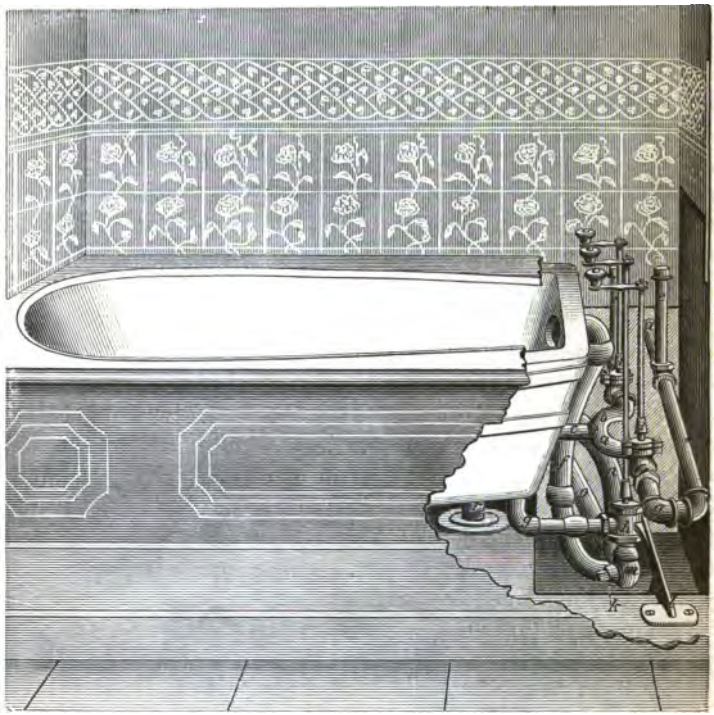


FIG. 44.—"India-Shawl" plumbing. ("Sanitary Engineer.")

and decorated tiles—possibly "hand-painted," so that when engraved for the mechanical periodicals, they look like sections out of India shawls—very beautiful, and perhaps to be commended as a remunerative outlet for the redundant decorative talent of the time; but all these things are by no means essen-

tial to efficiency. If it is objected that these prime essentials are so costly as to make it impossible to supply them, it must be remembered "that all that a man hath will he give for his life," and that there is a large field for cutting down in the finishing. Beauty depends on form and color, and not on the material in which it is embodied. A delightful sensation of harmony has been produced by a fireplace of simple bricks when beautifully shaped, and surmounted by a wood mantel that cost but a trifle, and which formed a support for æsthetic drapery, and both were combined with a wall of common plaster, colored by an artistic hand. A very complete and tranquillizing sense of beauty has been produced by a room hung with twenty-five-cent paper—but it was a copy from that which had been sold at fifteen dollars per roll, and had taxed the "brain" of a first-class artist to produce. But why dwell on these things? Here is the province for the employment of a true artist; and as for a thousand details, are they not written in the chronicles of "The House Beautiful," and a hundred other kindred works? "Hand-painting" is *not* essential to either health or happiness.

Of course, the *Hygeia* is to abolish mostly the murderous stair-climbing, so there will be a "lift" for articles, and an elevator for persons; but these will, if possible, be placed in the central court, and thereby never be made the conductors for fire if the wood-work of one room becomes ignited, and, what has proved equally fatal, smoke. The stairways will be of slate and iron; a coat of paint makes iron attractive, if it was originally well designed. Heating and ventilation have engaged the attention of so many able minds that no difficulty ought to prevent excellence; but as no expedient for ventilating a "living-room" equals the open fireplace, we shall expect to see a true fireside in place of a grated hole, in the wall or floor. It will cost something; but a very moderate doctor's bill will cover the cost of several tons of coal. By the complete abolition of corridors privacy would be insured, and the danger from the diffusion of contagious diseases lessened. Every room should have a window opening on a space which

is uncontaminated. If the central court is too small to allow of it, the roof, by the erection of a strong, high parapet, can be utilized as a play-ground for children as well as a space for drying clothes. The "solarium" of the old Roman houses may supply us with a fruitful hint. Here, protected by a parapet, the owner utilized his nearly flat roof: on a comfortable bench, high above miasms and dust, he sat and basked in the rays of the life-giving sunlight, and, had glass been as cheap and plenty as it is now, he would not have been slow to inclose with it a certain space to make him independent of the caprices of weather. Who will earn the gratitude of his generation by solving the problem of providing such safe and healthy homes for those who are neither the "million" nor yet the "upper ten thousand," but may be called the "refined forty thousand," who are expert in a perpetual struggle to make the ends meet; who, instead of selfishly isolating themselves in sumptuous bachelor apartments, have obeyed the diviner voice, "which setteth the solitary in families"? It took thirty years for Prince Albert's dream to become embodied in brick and mortar, and then to bring absolute demonstration out of it through careful records of what clean, healthy homes could do in prolonging life; they have not yet attained the sanitarian's dream of reducing the death-rate to ten per one thousand in the year, but they have far outrun the hopes of their projectors, and, as we are in the midst of new forces that swiftly mold the times, may we not hope that 1900 will see that a great amelioration has been wrought in the condition of this higher type of neglected classes?

CHAPTER X.

PUBLIC SANITATION.

A Short Tale of Two Cities.—When all has been done that is possible to render the building healthy, it may be neutralized by filthy streets. A series of careful experiments on the composition of the atmosphere of Paris was carried on for eight years. It was found to hold in suspension cotton, hemp, wool, hair, down, pollen, starch, particles of skin, carbon, silex and various salts, iron, dead insects, ova of infusoria, and especially spores of cryptogams and bacteria. The spores vary from three thousand in March to fifty-four thousand in June, in each cubic centimetre of air, and moisture increases their number. The mortality from infectious diseases increases with the number of bacteria. Is there any reason to suppose that the air of American cities is cleaner? Dickens asserted that the poverty of the Parisians caused them to seize upon and utilize articles that otherwise are left to decay, and that *par consequence* no other city to his knowledge was so clean. It is evident that we may imbibe blood-poisons "whene'er we take our walks abroad," for there is no knowing what added New-World substances go to make up the street dirt, say, of New York, and float in its ambient air, which has not been quite so patiently studied. Women can not sweep the streets, but they can see, and smell, and criticise, and urge their male relatives to assert their manly prerogatives, and see to it that the municipal ways are made smooth and clean, notwithstanding amazing and unforeseen difficulties may arise while they are making the attempt. In the winter of 1881 the death-rate rose so rapidly in New York as to arrest the attention of all, and a glance at the filthy streets ex-

plained one of the causes. It is one of those undemocratic facts that time will probably change, that the citizens of New York must appeal to the Legislature at Albany in order to be enabled to say how their streets shall be cleaned; they must borrow leave to cleanse their air, not only of the men who represent *them*, at Albany, but also of Mr. Jefferson Scattering Batkins, who dwells on the shores of the St. Lawrence. Mr. Batkins raises a great many potatoes, and, if a certain pending measure relating to the Batkinsville poor-house passes, he will have the monopoly of supplying the poor-house potatoes. It happens that a clique of men are determined that the streets of New York shall not be cleaned, as a monster mass-meeting of its citizens desire, because the mayor would be likely to give the sweeping and carting to men of the opposite political party; so they invite Mr. Batkins to vote with them, they pledging themselves to see that "that Batkinsville poorhouse matter" goes through all right. A good many other men who have personal schemes to forward act in the same way; and when the committee of twenty-one worthy citizens return to report their proceedings to their fellow-citizens, they have to confess that they have been nearly defeated, and that the law made is far from what it should be. Still, in the effort made, party bosses began to see a handwriting on the wall which indicates that men will resist the making of their life and health the foot-ball of party, and their own citizens, who *mis*represented so grossly their vital interests, have for the most part been elected to stay at home ever since. Lest this should be deemed unworthy of belief, here is the explicit language of Mr. Crasper, of St. Lawrence, during the debate: "This is not a question of cleaning the streets; business and politics are two different things. I believe that we, as members of the Republican party, should avail ourselves of the opportunity that is placed before us at this time. We have succeeded in carrying the State; we have the Executive; we have the Legislature; and now let us have what patronage belongs with it." And the Speaker, Mr. Sharpe, said, "It is evident that the mayor will nominate nobody who will give the patronage to

the Republicans"! So the majority of that Legislature straightway hastened to put themselves in direct opposition to the rising spirit of the age.

It is humiliating to think that our proud metropolis has a higher death-rate than Rome, or than any of the English manufacturing towns that we have accustomed ourselves to compassionately pity as centers of poverty and disease. It can not be excused on account of being "crowded." London is crowded, but has cleansed herself so that her death-rate is much less than that of New York. There is a little strip of one crowded thoroughfare that shows how such a street can be cleaned; it is that part of Broadway between Eighteenth and Twenty-third Streets. It is paid for by the people who have stores on either side, wholly by private enterprise, with no admixture of politics, and without the slightest reference to Mr. Batkins's potato-crop. It looks like a small section out of Boston or Brooklyn, is pleasant to see, and demonstrates that the thing needed to secure clean streets is a resolute determination to have them. The motive in the above case is the preservation of the valuable goods in the stores, but are human lives not of more value than many yards of brocade and velvet?

Death-Rate: what it means.—It means the number dying in one year among every one thousand people living in any given place. When a person reads that the death-rate of New York was 30·4 for one year, and 31·4 the next, it doesn't seem to be much of a difference, a mere unit; but here is the result when applied to the actual population: According to the last census, it was 1,279,560; now, if one person out of every thousand of these dies, it will destroy the lives of as many people as 1,000 will "go" in the sum total. Divide it by 1,000, we get 1,279, which is the additional number that will have died when the higher rate was prevailing. If an earthquake should come and swallow up 1,279 people, the whole country would stand aghast; but as these are removed, here one with pneumonia, and there one with fever, and as this process is taking place through the fifty-two weeks of the year, it attracts but little attention. A single epidemic will send the rate up tremen-

dously; that of New York, which of late years hovers between 26 and 30, went up to 44 when the cholera visited this city in 1854. Under the action of sanitary laws, vigorously administered, the death-rate in many of the large centers of population has steadily declined, and notably during the last ten years, so much so, that the most sanguine sanitarians predict that they will yet succeed in reducing it to ten in the thousand.

When every possible apology and allowance have been made for our commercial metropolis, such as the vast number of weakly immigrants who arrive and are never able to leave; the multitudes who flock hither to be treated for disease, and die here; and the fact that the census is taken at a season when the Superintendent of Vital Statistics believes the population is reduced by the summer exodus, there is still occasion for her citizens to blush when she is brought into comparison with other cities not nearly as advantageously placed by nature; true, since her Board of Health has been established and backed by public opinion, the death-rate has steadily declined, except in 1872, when a season of moist, hot weather swept off the infants like the sword of Herod, and again in 1881, when the reeking streets killed old and young. It can not be urged that her climate is so very different from that of Boston and Philadelphia; all are alike subject to those sudden, sharp changes in winter, from warm to cold, that develop epidemics of pneumonia, and in summer from cool to hot, that sweep off thousands with enteric diseases.

The death-rate of New York for 1880 was 26·47; for 1881, 31·08; for 1882, 30·06. That of Boston for 1882, was 22; that of Philadelphia, 22·3; Brooklyn, 25·7 (perhaps because she can clean her streets as she pleases). In Rome, which we have been taught to believe malarious and dangerous (but which has a water-supply of one hundred and fifty gallons per capita per diem), it was 26·1; in Paris, 26·3; and in Edinburgh, where splendid sanitary work is done, 19·7. London is divided into the "inner ring," comprising a space eleven miles square—here it was 21·4; and an "outer ring" in which it was 17·4. During the decade ending in 1881, only one of twenty of the great

crowded towns of England had a death-rate that began to approach that of New York. In Manchester it was 29. In the outer ring of London it was less than in the large towns. Why this difference? Principally because intelligent public opinion, enlightened by thirty years of unremitted "ding-dong" and effort, has the power to make itself felt, so that no English legislator would care to risk his popularity by even seeming to oppose any measure calculated to promote the sanitary welfare.

Some Results of Sanitation.—Nothing would more strikingly show the value of sanitation than the contrast between Peking, China, the center of a teeming population, but without sewerage, water-supply, street-cleaning, or other proper sanitary arrangements, and London, another populous center, but under very different sanitary conditions. The former, wading in barbarian filth, has a death-rate of 50 in the thousand, while London, where the light of intelligence has guided vigorous practical efforts, has reduced hers to 19·8. As America did not wake up to what might be accomplished till our mother-country had been diligently at work for twenty years, to England we must look for the solid fruits. The following shows the great saving of lives effected in England before 1880 :

The annual death-rate of England and Wales during the ten years which ended with 1880 was 21·5 per thousand of population. During the preceding thirty years it was on the average about 22·5 per thousand. The reduction for the last decade was therefore equivalent to nearly four and a half per cent. That is, about a quarter of a million persons were saved from death in the ten years from 1871 to 1880 who would have died if the rate of mortality had been the same as in the previous thirty years.

This reduction, too, it must be borne in mind, has taken place in spite of the increasing tendency of the population of England to concentrate itself in cities and large towns, where the death-rate is higher, for obvious reasons, than in the rural districts. It is the practical result of a system of public sanitary regulation which has been gradually perfected until it is now unquestionably the best in the world.

For about a quarter of a century England has been making a heavy outlay on sanitary works and sanitary service, and during more than half that time scarcely any gain in the way of improvement of the public health was apparent. The officers of the Government boards for the removal of nuisances were putting to the test theories of medical men, which had never before been so thoroughly tried. They encountered the opposition of landed proprietors, and ridicule was sometimes poured on their efforts because the results produced appeared of so trifling consequence. But at last the reward has come, and the wisdom of their regulations is amply vindicated in the saving of a quarter of a million lives.

But the decrease in the number of deaths by no means represents all the good accomplished. For every person who dies, there may be reckoned twelve cases of illness which are not fatal. It therefore follows that about three million people, or one ninth of the whole population, were saved from a sick-bed by the operation of influences which were not previously working. Moreover, of the entire reduction in the death-rate during the decade, three quarters come under the head of "the seven zymotic diseases," the ones against which sanitary improvements are particularly directed, and which sanitary regulation has most power to prevent.

Mr. Edwin Chadwick recited these facts in an address before the recent Sanitary Congress held at Exeter in England, and added to them estimates of the pecuniary saving which the decline in sickness and death had brought about. The cost of funerals all round he placed at twenty-five dollars each. The number of funerals having been less by about a quarter of a million, the gain under this head was over six million dollars in the decade. The direct cost of sickness he estimated at five dollars a case. The saving on this account, therefore, was fifteen million dollars, if we put the reduction in the number of cases of illness at three millions. But the whole gain was far greater. The earners of wages lost much less time from labor than previously.

And yet sanitary science has only begun to do its work.

The reduction of the death-rate by four and a half per cent, was only a first step in its progress. In particular localities it has effected a saving far greater than that. Thus, at Croydon the rate has been reduced from twenty-five to sixteen per thousand, and, when the sanitation is complete, it is expected that it will fall to ten per thousand. In London itself the death-rate of the working-people in their ordinary dwellings is thirty in the thousand, while in the model dwellings it is only sixteen or seventeen. Mr. Chadwick accordingly puts the reduction in the general death-rate obtainable by advanced sanitary administration and further sanitary works, at three times the four and a half per cent already saved.

A Woman's Hand on the First Link in a Great Chain of Events.—When Florence Nightingale went to the Crimea in 1854, she did a great deal more than to create a new system of nursing and care for sick soldiers, by showing what light and air and good food could do, to recover the sick, and to fortify the well against the onsets of disease. She put a new set of ideas into the minds of the military authorities at home, and, seeing what could be accomplished by preventive medicine, a set of sanitary rules was at once formulated and applied to the English army in India. When the English soldier has arrived in India he is an expensive article, and it is for the interest of the Government to keep him alive and well as long as possible, and being a soldier he can be subjected to strict discipline: here is a field where men are coerced into health, and with what result? The death-rate is only one third of what it formerly was. No detail is thought too small to be attended to; the men are required to wear a "cholera-belt"—a "shaped" flannel band to protect the abdomen from changes of temperature, and, with the thermometer at 120°, thoughtless men might be tempted to remove it, but twice a day a superior officer *sees* that it is in place. Accurate statistics showed the great saving of life, and thorough sanitary rules were soon applied to all the reformatories and prisons at home, and it was found that the pure water, nutritious food, and pure air had so "built up" the prisoners, that epidemics passed them wholly by. The mortality in

the home army was reduced to three fifths of what it had been; and these hints not being wasted on an intensely thorough and practical people, millions of dollars were very soon invested all over the kingdom in the construction of water-works and drainage schemes. Everywhere there followed a direct diminution of the death-rate. The enforcement of hygienic rules has so improved the health of American convicts that Mr. Beecher says, "We may well sigh for some salubrious jail, where nothing but the shortness of the sentences keeps men from living to the age of Methusaleh!" Newcastle-upon-Tyne has spent $3,000,000 on sanitary improvements within the last eighteen years, but has reduced her death-rate ten in the thousand. Could as great a reform be wrought in New York, it would save more than twelve thousand lives annually. At present the whole mind of the English nation is aflame with zeal. Sanitary primers are printed and put into the schools in India. Parliament enacts laws that secure a perfect system of registration as a foundation for exact deductions, and provides inspectors for dairies and cow-sheds. The Duke of Albany opened the Parkes Museum of Hygiene, where every life- and health-saving appliance is exhibited, and courses of sanitary lectures are delivered by the most accomplished scientific men. In practical applied sanitation, England is many years in advance of us.

Wanted, an Epidemic.—While twenty-seven State Boards of Health are doing much to draw our country forward to the same advanced line as that now occupied by England, the attitude of the General Government of our national legislators "in Congress assembled" is not such that we can "point with pride" to it.

The only thing that scourges Congress up to any worthy action is an epidemic, either in progress or threatening; so that while other nations are inaugurating broad and wise and statesmanlike measures, our Government stands in the attitude of the typical bad boy who is "good" just as long as the impending switch is in sight, but returns to his evil ways directly it is laid away. The mischief of this puerile and short-sighted

policy would be of less consequence if invading epidemics paid any attention to state boundaries. In Germany the crown prince himself opened the Permanent Sanitary Exhibition in Berlin; and the Government is at this moment employing the famous Koch, with a competent corps of assistants, to learn, if possible, the cause of cholera. Italy is pursuing a scientific investigation of the cause of malaria. France has a cholera commission in Egypt under the direction of Pasteur, and has lately pensioned him and his children; while the Congress of the United States has cut down the yearly appropriations for the work of its National Board from $500,000—at first to $50,000, and then to $10,000, "for pay and personal expenses of members of the board," and entirely failed to make any appropriation for the editing and printing of the "Weekly Bulletin of Vital Statistics," which was doing a great work in establishing a uniform system of registration, and for scientific investigations and sanitary surveys; so that, while millions of dollars were appropriated to dredge out lazy streams that lead from Nowhere to Nowhere, and fertilize the pockets of the "districts," not half a mill a head could be had to save those constituents from such an invasion of small-pox (from an immigrant-ship) as cost the city of Davenport, Iowa, $30,000 to stamp out last year!

Says Dr. I. B. Lindsley, "When Christian civilization shall so assert its pre-eminence as to cause governments, which are merely the combined morality and intellect of peoples, to expend upon the advancement of science a very small proportion of the life and treasure now criminally wasted upon the maintenance of large armies and the invention of implements of destruction, all the problems touching upon the origin, progress, and prevalence of epidemics, and upon the movements of atmospheric currents, will be speedily solved, and the mystery attending upon each completely removed."

Washington, like all places that have paroxysms of pressure for temporary quarters at almost any price, and then the long seasons during which the interest account eats steadily on, night and day, and the income is *nil*, is peculiarly liable to

have many cheaply built structures among its dwellings. The defects in the White House, at the time of President Garfield's wounding, roused the health authorities, and during the autumn of 1882 the inspector of plumbing found such defects as are shown in the six accompanying plates. With these in view, there will be no need of fancying that any particular row of

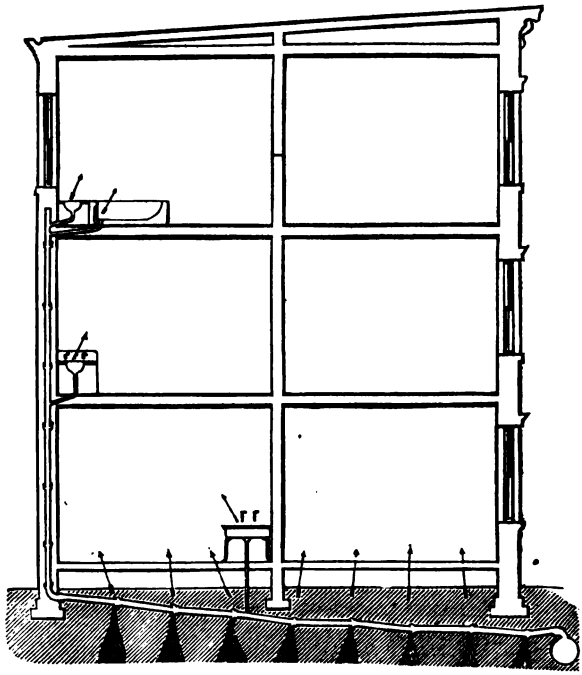


Fig. 45.—Condition of one of a row of houses in the southeast part of Washington, showing no trap to any fixture in the house, and the underground drainage defective. ("Sanitary Engineer.")

seats in Representatives' Hall has such inherent seeds of death in it as to make it deserve the name of "Fatality Row," while it goes far to show why so many stalwart men have been sadly and silently borne back to homes whence they came full of high hopes and noble ambitions.

What Sanitation has already accomplished.—The earliest sanitation that history has preserved any account of, are the rules laid down by Moses for the regulation of the diet of the Israelites, for the isolation of those affected with contagious diseases, especially leprosy, and the burning of infected clothing; but in more modern times, it may be said that *sanitation*, i. e., an intelligent adaptation of the forces of Nature to the im-

FIG. 46.—Defective connection of kitchen sink; showing necessity for brass thimble and plumbers' wiped joint, in connecting lead with iron pipe, and for Y-branch, with one-eighth bend on line of main drain in cellar. ("Sanitary Engineer.")

provement of health and the lengthening of life, began when an observation of the facts and processes of Nature was substituted for wild and visionary guesses, theories, and superstitions. We—heirs to the researches and efforts of myriads of bright, inquiring minds—can form but a meager notion of the sufferings and multitude of deaths produced by insufficient food-

products, not more than three hundred years ago. Then, if the season was in any way abnormal, if unusual rains caused floods so as to destroy a portion of the year's crop, or a drought prevented its full development, it meant a condition of semi-starvation to a large majority of the population, and left them

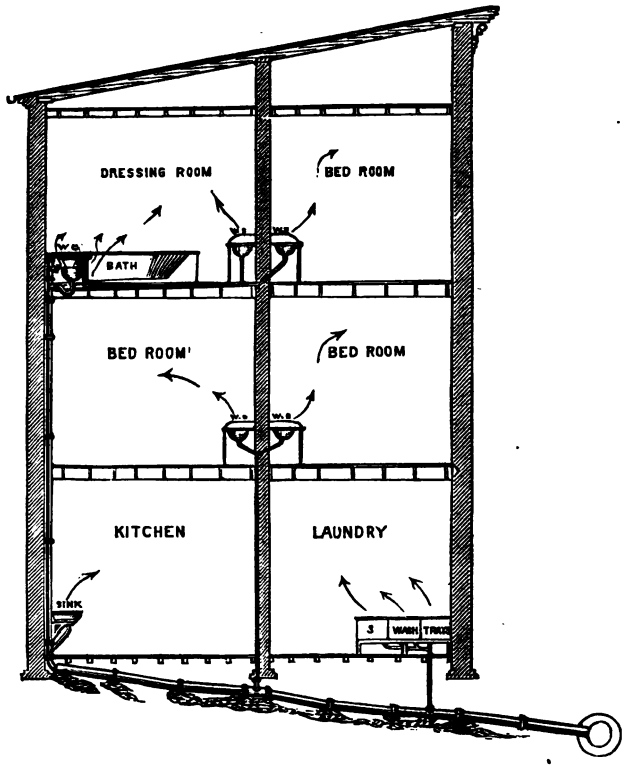


FIG. 47.—Condition of plumbing and drainage in dwelling on I Street, between 12th and 13th, previous to being remodeled. ("Sanitary Engineer.")

with vital forces so reduced that it only needed the return of a party of infected crusaders, or possibly a single sick pilgrim, to plant the seeds of disease, from whom soon radiated a "plague," a "pest," or a "black death," that consumed the

people, just as a match applied to a prepared pile of shavings soon leaves but a smoldering remnant. No fact in the history of those decimating invasions is more striking than that they were always preceded by famine, so that they always attacked a population reduced by fasting, and with blood already

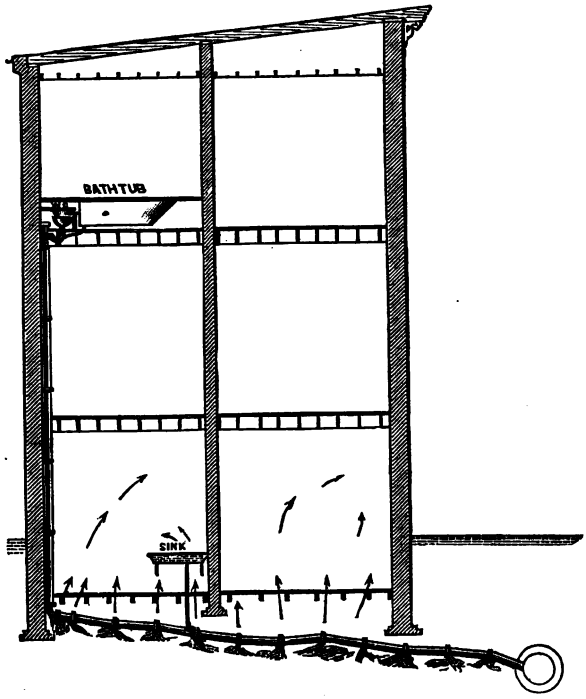


FIG. 48.—Condition of drainage and plumbing in a first-class residence on 17th Street, N. W. ("Sanitary Engineer.")

poisoned besides by unsanitary surroundings. The so-called "famine-fever" of Ireland to-day bears a striking family likeness to this disease. It is estimated that it swept off 25,000,000 people in its successive visits to Europe; and it is known that in one epidemic it destroyed one third of the entire population of France. The superstitious mediæval peoples stood in trem-

bling awe of them, and called them "visitations of God"; but who fears a general decimation from them now? Till the light of Christian civilization has illuminated the entire Orient, there will be occasional outbreaks of it; but modern Science stands fearless in its presence, and by isolation, proper medication, and disinfection, disarms it of its terrors. In the year 1664–'65 it destroyed 68,596 lives in the city of London, but since the purification of that city by the great fire of 1666 it has never visited it. It can be found in unsanitary Constantinople and Cairo to-day.

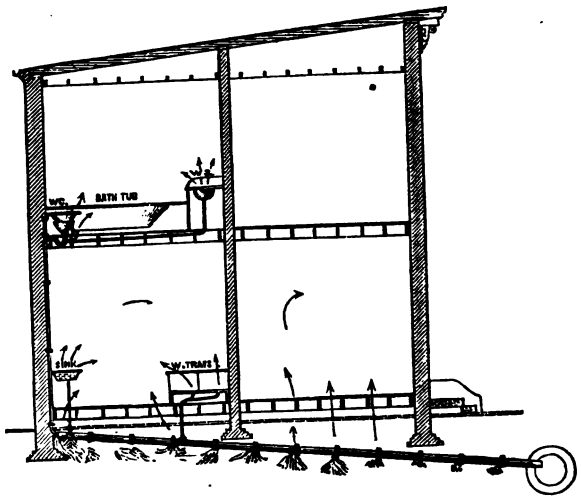


FIG. 49.—Condition of one of a row of houses on Capitol Hill, showing defective plumbing and drainage, and no ventilation. ("Sanitary Engineer.")

It is impossible to measure the immense boon to mankind conferred by scientific farming applied to both vegetables and animals, thereby multiplying the food-supply many fold. The original wild apple of the forest is a sour and bitter crab, less than an inch in diameter. Cultivation has produced hundreds of delicious varieties, and single specimens weighing more than a pound. The same process of improvement has been applied to hundreds of nutritious vegetables: the weight of sheep and

cattle has been doubled within a hundred years, and, though accurate records on which to base conclusions are not as plenty as might be wished, statisticians estimate that by the mere ability to obtain enough good food the mortality has been reduced one half in France, and a similar diminution of death, and pro-

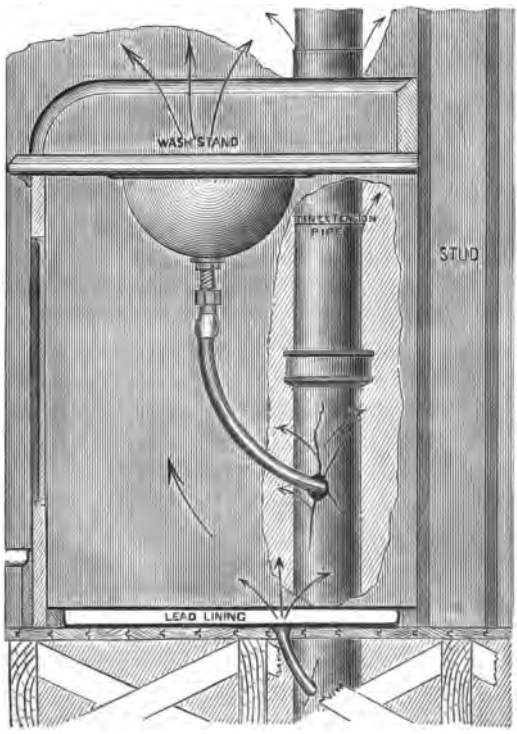


FIG. 50.—Condition of stationary wash-stand and waste-pipe, as found in many first-class dwellings. ("Sanitary Engineer.")

longation of life, have taken place among other nations; and as Dr. Edward Jarvis finely says: "Beyond the pale of man's intelligent aid, life is apparently stationary. So far as human observation has gone, the wild, uncultivated plants, the trees of

the forest, the grass of the meadows, the flowers of the untouched wilderness, the fishes of the sea, the birds of the air, the wild beasts of the desert left to their own instincts, are no larger nor stronger; they have no more vital force or longevity than in the beginning of their race on earth."

Man himself has followed in the same path of improvement that he has applied to the inferior animals, so that the notion that the human race is degenerating, is only the puerile commonplace of uninformed minds, and the fact, borne out by incontrovertible figures, is, that

Human Life is steadily increasing in Length.—In ancient Rome, in the third century after Christ, the average duration of life in the most favored class was thirty years (of course, it was much less among the poor). In the present century, the average longevity of the same class is fifty years.

In the sixteenth century, nearly twice as many died before they reached maturity, at twenty, as do now.

In the sixteenth century, three persons out of a hundred survived seventy—now eighteen do.

In 1790 Mr. Pitt issued a tontine, or scale of annuities, calculated on the basis of a similar scale that had been issued in 1693; but he neglected to take into account those changes in the conditions of life that had so expanded it, that the annuitants lived so long as to make it a very costly loan to the Government. Within the century preceding the issuing of the tontine, the longevity of this class of people increased twenty years. More than three hundred years ago, some forgotten genius in Geneva, Switzerland, perceived that careful records of vital statistics would be well worth the keeping, and caused them to be established, and the Genevan record demonstrates that in each fifty years the average longevity has steadily increased, so that now it is nearly double what it was in 1550. It also shows that the average working period was increased from eight years and five months to twenty-two years and eleven months, and consequently old age is postponed. "Those who were formerly old at fifty and decrepit at sixty, are now old at seventy and decrepit at eighty."

The Control of Epidemics.—The splendid mastery of knowledge over the forces of Nature has no more triumphant illustration than the abolition of the ravages of the small-pox. Before vaccination, it slew one tenth of the people, and left another tenth frightfully disfigured. Cholera gets no foothold where people are compelled to lead hygienic lives, as has been demonstrated in English prisons. During the last century ten thousand men were disabled from scurvy in the English navy at one time; the free introduction of fruit and vegetables put a stop to it, and now no commander expects to have his force diminished, much less disabled, by it. The terror of jail-fever is at an end, a true knowledge of the composition of the air having revealed how some diseases were spread and how to check their ravages. The protection of wounds from suppurative inflammation by the antiseptic methods, which all simply means *keeping germs out of them*, has saved thousands of lives, and rendered many operations possible that would not have been undertaken thirty years ago.

Early in this century epidemics of yellow fever ravaged New York and Philadelphia; now, though they are grown to populous cities, instead of being simply large towns, by sanitation they have become so much healthier that no one fears a desolating epidemic of this disease.

We are not apt to think of consumption as an epidemic disease, but in the year 1880 it caused ninety-five thousand deaths in the United States, and only lately have we begun to think of it as a disease communicable by contagion; and, whether the theories of Koch shall prove true or not, it has been shown that much can be done to prevent its development, even in those who carry a hereditary taint of it. But one of the most striking results of statistics, thoroughly kept in Providence, Rhode Island, is to show that the death-rate from this cause has steadily declined during the last twenty-five years among persons of American parentage (those who have applied intelligent sanitation and lived hygienically, it is fair to presume), while it has remained almost stationary among persons of foreign parentage, both being alike subject to the general influ-

ences of atmosphere, earth, and season. Among the Americans, in 1856, there was one death in every two hundred and sixty-eight; in 1880, one in four hundred and thirty-five; while among those of foreign parentage in 1856 it was one in two hundred and sixty-two; in 1880, it was one in two hundred and sixty-eight.

But why multiply examples? On every hand human life is rendered longer, safer, and richer in all that makes it worth the living, by sanitary progress.

The Sanitary Signs of the Times.—While England was investigating, and discussing, and deciding many important sanitary questions, the United States was engaged in a struggle for national life that absorbed every faculty; but as soon as she had time to gain breath she began to perceive that she was being "left behind" in a most vital interest. One of the beneficent incidental consequences of the war was the accumulation of a vast fund of sanitary experience, and the demonstration that hygienic lives and healthy surroundings make healthy men. The older section of the Anglo-Saxon race were not slow to utilize this fund, and the Continental countries followed suit; and the progress there reacted on America, so that in 1869 the first State Board of Health was established. Now there are twenty-seven. Each is a focus of light. The history of the earlier ones is similar. Their establishment in the abstract was hailed as a great step forward by all classes of people intelligent enough to appreciate their scope. They began to *act*, and then there were many people who found themselves in the predicament of the famous Ensign Stebbins, "I am for the law, but ag'in its execution." When they attempted to interfere with ancient vested abuses, or to show that this or that man was poisoning the air of a whole neighborhood, or destroying the lives of his operatives by injurious processes, or selling adulterated food and drugs, they naturally raised up enemies, and occasionally most unscrupulous ones, and these men, active, alert, compact, with pockets fat with ill-gotten gold, could and did bring influences to bear to cripple the boards; while righteous indignation, however intense, is vague and unconcentrated,

but generally in time proves to be a *vox populi* that gets itself heard. Fortunately, what was a dominant interest in one State was perhaps of little account in another, so that a proposed reform, thwarted in one, has had free course and been glorified in another just over the border, till now they are kindling-lights around the whole circle of the horizon. An idea once launched, can not be stifled, and pays no attention to state lines; so there is a power silently gathering force, an instructed public opinion that will yet consign to merited obscurity those who can not see that the "right to life" includes the right to have that life made as safe, as free from pain, and as long as possible. Like all reforms, the sanitary has had its reactionary stage, when its advocates have been granted scant hearing, but meantime light and knowledge have been increasing, till soon the resistless force of sheer truth will carry it forward in spite of the positive obstructionists, or the party of apathy.

Many of these boards are causing scientifically correct but condensed statements of what course to pursue to ward off the onset of an epidemic, or how best to cope with it when once it has gained a foothold, to be sown broadcast throughout their States; and these "talking leaves" have saved multitudes of lives. The air is full of "sanitation," and it is hard to take up a magazine or a newspaper that hasn't its article or its item on some of its numberless themes.

Educators are arranging courses of hygienic and sanitary study. The Sheffield Scientific School has a comprehensive course of lectures that covers the whole sanitary field; in Boston a set of college alumni meet to discuss sanitary topics. It ought to give a fillip to their studies to recall how many of our institutions of learning have been visited by epidemics of preventable disease. The professors know more about Greek roots than they do of those that penetrate drain-pipes and choke them, and thereby create a noisome nuisance.

One principal of a school for young women has courses of sanitary lectures given by competent and interesting men, and the graduates of one woman's college have stated meetings for the discussion of sanitary and hygienic subjects.

There is already a "live," able, and instructive periodical literature devoted to sanitation, both at the East and West; nearly every month sees the issue of a book on some phase of the practical technical work to be done, so thoroughly illustrated that any quick, nimble-minded woman can take it in; the fifteen years in which the seed has been silently germinating are about to bear fruit, and soon every true mother in America will be able to make an intelligent demand for a sanitary home. When that day comes, there will be a resistless public opinion that no politician who hopes for a future can afford to neglect, or ignore, or defy.

Doctors.—In the happy era of preventive medicine will the doctors awake to find themselves superseded? Not at all. Medical manners may change, and possibly, with advancing civilization, we may establish the custom of giving our doctor a liberal honorarium on New-Year's Day, the acceptance of which on his part will be tantamount to a contract to keep us well during the year; but the human machine has infinite complexities, the accidents and contingencies to which it is exposed are numberless, and, with all the preventable diseases eliminated, their task will be no light one. They have absolutely nothing to fear from the advancing hygienic intelligence of the public; it is the ignoramus who buys and boldly swallows a "patent" medicine of whose ingredients he knows nothing, who "doctors himself," or confidingly places himself in the hands of some "celebrated Indian doctor."

The man who can intelligently

> ". . . mark the cloven sphere that holds
> All thought in its mysterious folds,
> That feels sensation's faintest thrill,
> And flashes forth the sovereign will"—

he who can at all adequately

> "Think on the stormy world that dwells
> Locked in its dim and clustering cells,
> The lightning-gleams of power it sheds
> Along its hollow, glassy threads"—

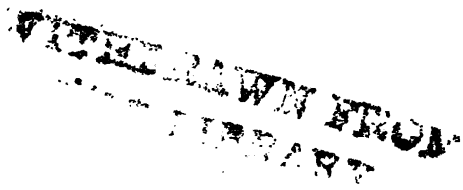
will want a man who has devoted his life to the study of it to undertake repairs when his system gets out of order.

Sanitary science has been mainly created by the medical profession. It began in England with Dr. William Farr's statistical tables, which marked out the geography of a hitherto unexplored physiological and hygienic continent. At each successive stage in its advance we find a mile-stone bearing some illustrious name followed by "M. D."; although, while collecting facts in their own province and devising methods, they have not been slow to seize and adapt the discoveries of scientists of every name.

In America the essays embodied in the reports of the State Boards of Health constitute a mine of golden truth which will yet be coined for popular use. With rare exceptions they are the work of the progressive doctors of the day. The nineteenth century, with all its marvelous subjugation of the subtile and Titanic forces of Nature, shows nothing more wonderful than the vast body of sanitary science now in existence, and already applied to the beneficent work of ameliorating man's physical condition.

It has been called into being by a glorious phalanx of medical men, alive, alert, courageous, and steadfast in the strength of earnest conviction:

"Along its front no sabers shine,
No blood-red pennants wave;
Its banner bears the single line,
'Our duty is to save.'"



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